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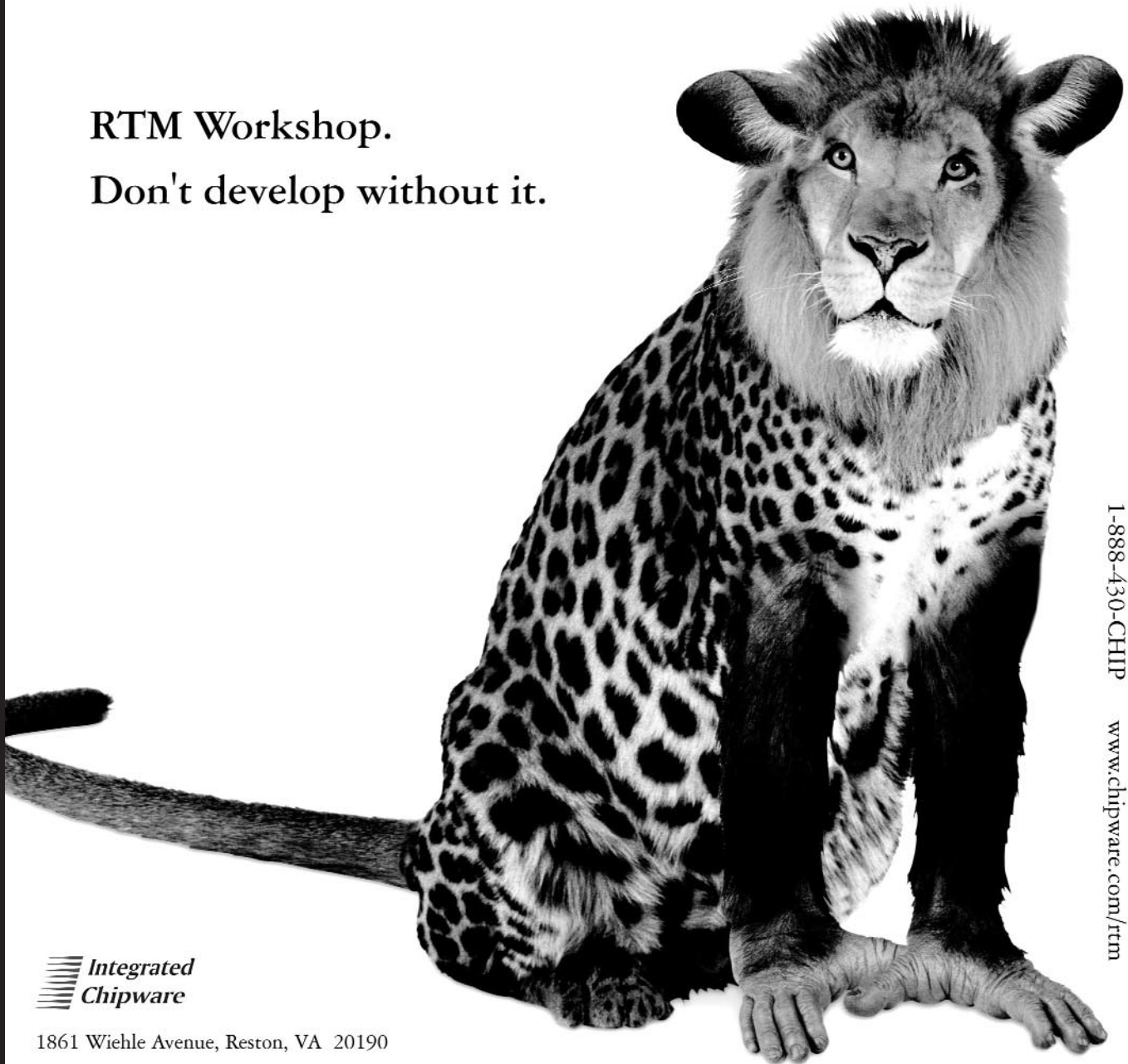
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INSIGHT SPECIAL FEATURE

Commercial Activities in INCOSE

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Copy Editors: Lori Pajerek, Shirley Bishop

Who are we? INCOSE is a 3800+ member organization of systems engineers and others interested in systems engineering. Its purpose is to foster the definition, understanding, and practice of world class systems engineering in industry, government, and academia. INCOSE is comprised of chapters located in cities worldwide and is sponsored by a corporate advisory board and led by elected officers, Regional Directors, and Directors-at-Large.

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From the Editor

Commercial Activities in INCOSE

This *INSIGHT* theme focuses on the increasing call from the commercial sector for guidance on how to apply the Systems Engineering process to their businesses. The articles in this issue provide some detailed examples of how INCOSE has been responding to this call. The chart below (compiled by Bill Mackey, Chair of the Systems Engineering Applications Technical Committee) clearly shows the growing interest of the INCOSE membership in the application of Systems Engineering in commercial sectors.

	1992	1993	1994	1995	1996	1997	1998	1999
Symposium Papers in Commercial Domains	6	18	17	20	29	27	30	42
SE Applications Technical Committee WGs/IGs	1	1	2	3	5	7	7	9

In the first article, James Martin illustrates how the commercial sector is looking for guidance to apply Systems Engineering to their businesses. James discusses the status and potential application of the ANSI/EIA 632 standard in the commercial sector. INCOSE developed this standard jointly with the EIA G47 Systems Engineering Committee.

Peter Baxter, in the next article, discusses the similarities and differences of measurement processes between the commercial and government sectors. He points out that a good measurement process is an important aspect of management. Peter not only contrasts the measurement processes in the two sectors, but also explains why those differences occur.

The next article describes how a company in the commercial services sector, in this case Citibank, uses a measurement process to insure success of its projects. Jackie Burton and Larry Cornell explain how their

company uses the Balanced Scorecard Method to achieve success in their industry. Jackie and Larry also discuss how they use this model in conjunction with a simulation model to allow their management to make the best possible decisions.

The work being done by the Model Driven System Design (MDSD) Working Group of the Modeling and Tools Technical Committee is highlighted in another article. Fred Knopf and Peter Scott provide some details of the MDSD Working Group's current work and future

goals. A brief summary of the results of a panel session, conducted at Brighton, is also discussed. The panel session demonstrated the applicability of the MDSD approach in a variety of domains.

Peter Sydenham focuses on the key issue of staff development. He specifically explores what is required to achieve the goal of establishing and sustaining a successful SE organization in a company. In order to help companies accomplish this goal, Peter suggests that INCOSE should develop the necessary guidance.

The final article discusses work of the Joint Commercial Aircraft Working Group (JCAWG). In this article, Greg Mathers highlights the current status of the JCAWG and where the Working Group is headed. This Working Group's membership comes from several professional organizations, aircraft manufacturers and suppliers, and regulatory agencies. The JCAWG is attempting to define potential

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President's Corner

Ken Ptrack, ptrack_ken@prc.com

INCOSE '99 – A Roaring Success

I just returned from an extremely successful 1999 Symposium in Brighton, England. I know that everyone that attended enjoyed it as much as I did. Thanks to the spirit and leadership of Peter Robson, the Symposium Chair; Allen Fairbairn, the Technical Chair; the 1999 Symposium Committee; and the United Kingdom Chapter, the first INCOSE Symposium conducted outside the North American continent was a roaring success.

We had 713 delegates from 21 countries participating in the tutorials, academic workshops, presentations, panels, technical tours, and vendor demonstrations, and sharing a variety of leading-edge technologies in the areas of systems engineering. Of these attendees, we gained 170 new members. We had 196 exhibitors and press representatives participating to promote INCOSE and systems engineering principles. In addition, during the week attendees provided inputs to the Technical Working Groups and INCOSE Committees. Sir Robert May, Laurie Taylor, Professor Joan Solomon, and Professor Philip M'Pherson all provide enlightening and entertaining talks to help us Share the Future.

As symposium attendees were working, Board of Directors and Technical Board officers, under the leadership of Dr. Donna Rhodes, INCOSE President Elect, participated in working sessions to refine the *INCOSE Strategy 2000*. INCOSE Strategy 2000 is a comprehensive five-year strategy to take INCOSE into the next century. The two components of *INCOSE Strategy 2000* include our Strategic Directions and our *Strategy 2000* Master Plan.

Our Strategic Directions describes INCOSE's vision, mission, core values,

and strategic goals. The *Strategy 2000* Master Plan will detail initiatives and underlying investments to achieve the strategic goals. In addition to the Board of Directors and Technical Board officers, the Chapter Presidents are included in the review of the *INCOSE Strategy 2000*. When completed, it will be posted on the INCOSE Web page.

During the banquet Wednesday evening, the INCOSE 1999 awards were presented. The Pioneer Award was presented to Eberhardt Rechtin, for his achievements in the engineering of systems, and his contributions to major products and outcomes that have enhanced society and its needs. The Founders Award was presented to Virginia Lentz, a distinguished member who has made a major contribution to INCOSE. This year we selected three Fellows for definitive contributions to the management of systems engineering processes. They are Elliot Axelband, The University of Southern California, John Velman, Hughes Space Communications Co., and Wolt Fabrycky, Virginia Polytechnic Institute and State University. In addition, we presented an INCOSE Service Award to Dr. Jerry Lake for his contributions to International Standards development.

To my pleasure, I received many comments from "Satisfied INCOSE Customers," both during the symposium and via messages upon my return. I have included a few here for your review.

■ "I just returned from Brighton and want to tell you I thought it was one of the finest symposia I've ever attended — of any organization. The arrangements, etc. were very well done. But even more important was the nature of the papers and the people I met. I came away energized and charged up

beyond the level I've felt in a long time, and hope to accomplish some good things as a result of this "re-charge" of my batteries. And I'll be there in Minneapolis and in Sydney to get re-charged again!"

- "My respect for INCOSE grew enormously as a result of the symposium."
- "I am taking the opportunity to pass on compliments on a great symposium, venue and reinforce the comments already expressed during the week."
- "We who go to the symposium every year have higher and higher expectations, and each year we learn that more and more can be accomplished. This year, we learned that a symposium can be planned a very long way from the people and places where symposia have been before. Those of us who have been around for a while have learned that, like much of systems engineering, the things we work hardest on to make them go well are invisible and unappreciated, and those that have problems stick out like sore thumbs, for people to complain about. Frankly, from this vantage point of a few days and a few thousand miles, I can't remember a single thing I found appalling or even persistently annoying. Yet I feel fairly confident that whatever people were annoyed with found a way to your ears and those of the Symposium Committee during week, whether they were things under your control or not. Allow me to enumerate some of the things I found went well:
 - The hotel was in a beautiful location, truly easy to get to via train and taxi. The hotel had a room for me when I arrived at 0830 — almost 8 hours before the advertised time. The chambermaids were efficient and invisible. The rooms for the working groups were well

signed, of appropriate size, and had the right equipment in them. We were not bothered by requests to clear out so they could set up for the next group: Someone had arranged enough set-up time between events. Audiovisual equipment was where it needed to be, at the right time, and generally worked, and when there were problems, staff was there to fix the problems within minutes. The registration area was fully functional and staffed by people who had clearly made appropriate preparation, and I do know what it takes to stuff all those bags and envelopes. At the last conference I attended, people received tickets that didn't match what they had paid for, or had no information on them — ours were correct and informative. The speaker prep room had computers running for each presentation room so it was a no-brainer how to put my presentations on. Session chairs were well prepared. There was water for the speakers. Food was ready when due for breaks and lunch. The banquet ran smoothly. A waiter even inquired about "special food needs," which reminded me to be cautious about my allergies to mushrooms. Keynote speakers knew where to be when, and in all the cases I saw, were relevant and interesting."

- "There was plenty of informative information available on the web in advance of the symposium. In general, I can't remember a symposium that was clearly better run, and I have been going since 1992. Three cheers for a job well done!"
- "The 1999 INCOSE Symposium, held last week in Brighton, England, was a huge success. Over 700 attendees took in presentations covering a wide

range of topics, and visited exhibits by several dozen companies."

I hope that everyone that was able to attend *INCOSE '99, Sharing the Future*, found their participation as rewarding as I did. I would like once more to express my sincere thanks to the Patron Organizations, the Corporate Advisory Board Organizations and most importantly to **YOU**, the reason for INCOSE. At this time, I reiterate my challenge to you — pass the word about INCOSE to your friends and associates. Get them involved and **SHARE THE FUTURE**. I look forward to seeing you in Minneapolis next July.



Ken Ptack
INCOSE President
Litton/PRC Inc.

From the Editor

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benefits of applying SE process, methods and tools to the commercial aircraft domain.

All of the articles in this issue show that there is a trend in the commercial sector to explore the use of the Systems Engineering process. The range of articles demonstrates the potential application of Systems Engineering across many domains. INCOSE has been keeping pace with this increased interest of Systems Engineering in these "non-traditional" domains. The number of INCOSE Interest Groups and Working Groups addressing these non-traditional domains has grown from one to nine in the last seven years. This level of responsiveness by INCOSE will allow it to influence significantly

A REMINDER

October Elections

Bill Schoening, schoening@incose.org

This coming October we will be electing a new President Elect, Treasurer, and six Regional Directors. Each member will receive a ballot in the mail, but the resumes of the candidates will be available only on the INCOSE Web site in the Members Only area. This approach will significantly reduce our mailing costs for the election. If you are unable to obtain access to a computer to view or download these resumes, please send a written request to the central office requesting a printed copy through the mail. Remember that copying, packaging and mailing the resumes costs INCOSE several dollars for each such request, so please try to find a way to access the web site or get a copy from a friend.

the understanding and usage of Systems Engineering across domains and provide the necessary leadership and guidance required for success.

Look for more information in upcoming issues of **INSIGHT**. Currently, we have a pledge for a series of articles by Elliot Axelband, R. Campbell, and Don Clausing. Theme authors for upcoming issues are also ensuring a mix of domains and opinions to help this organization understand and practice sound systems engineering principles.

Sincerely,
Pat Sweeney
Theme Editor

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Status of ANSI/EIA 632

James N. Martin, j-martin@raytheon.com

The ANSI/EIA 632 standard was under development since 1994 and is now available for purchase from Global Engineering Documents at <http://global.ihs.com/>.

ANSI/EIA 632 is the U.S. national standard intended for specifying the "processes for engineering a system." It contains 13 processes and 33 requirements associated with these processes. It also contains representative tasks for each process and expected outcomes for each of these tasks. Further information on the ANSI/EIA 632 standardization activity can be found at: <http://www.geia.org/eoc/G47/main.html>.

This standard was developed jointly with participation from INCOSE and the EIA G47 Systems Engineering Committee. EIA is the Electronic Industries Alliance

<www.eia.org>, an alliance of trade associations and other groups in the United States.

It is expected that second tier standards will be developed for different technology and business domains using ANSI/EIA 632 as a generic framework. Also, system developers will use ANSI/EIA 632 as a basis for developing their internal policies and procedures with respect to their product development activities.

INCOSE working groups can use this standard as a common framework for developing working group products. It is expected that this standard will help standardize some of the terminology used in the practice of systems engineering.

Another related standard released in early 1999 was EIA/IS 731, a stan-

dard that defines capability measurement of systems engineering within an organization. This document is free and can be downloaded at this Web site: <http://www.geia.org/eoc/G47/page6.htm>

EIA/IS 731 is being used as the basis for the systems engineering portion of the Capability Maturity Model Integrated (CMMI) which will be published in 2000. The CMMI document will define an integrated capability model for systems engineering, software engineering, and integrated product development.

James Martin is a Fellow member of INCOSE and leads the Standards Technical Committee. He led the combined EIA/INCOSE effort in developing the ANSI/EIA 632 standard. He works at Raytheon Systems Company on airborne and satellite communications network systems.

Contrasting the Measurement Process Between Commercial and Government Sector Organization

Pate Baxter, pbaxter@distributive.com

Introduction. A measurement process has become a required element in the management of software-intensive systems development. Because the issues that affect systems engineering organization are unique, no two measurement process implementations are exactly the same. In this article, I compare the measurement processes of organizations developing government systems, and those developing commercial systems. The similarities and differences in the use of a measurement process within these two broad sectors (commercial and government) are described.

This article reflects my experience in planning, implementing, and supporting organizational measurement processes within government (including Army, Navy, Air Force,

and defense contractors) and the commercial sector (including software development, networking and telecommunications).

Similarities and Differences between the Sectors.

Before looking at why these two sectors implement measurement processes that focus on different goals, issues and objectives, an enumeration of their similarities and differences is first presented. At first, it might seem that these sectors could have very little in common—different technology, different markets, different management structure, etc. However, despite some major differences in the business model (more on this later), there are measurement process similarities, as listed in Table 1 (following page).

Measurement Process Drivers. It is not reasonable to simply compare the measurement processes of these two sectors without discussing differences in the basic business model of each. Organizations develop management processes, including a measurement process, to operate successfully in the associated business model.

The government sector business model must address the following:

- The size, scope and integration of defense systems is usually much greater than in the commercial world. Government program offices typically hire a few contractors, who in turn hire a larger number of subcontractors.
- The length of the typical

Table 1: Similarities Between Commercial and Government Sector Measurement Processes

Measurement process similarity	Description of common element
Use of measurement plan	The development and use of a measurement plan is a common element in both business sectors
Metric selection	Goal-Question-Metric (GQM) or Practical Software Measurement (PSM) is the most popular technique for determining metrics from information needs.
Collection frequency	The most popular data collection frequency is monthly data collection.
Defect measures	The use of process and product defect metrics is a common component in both sectors.

Table 2: Differences Between Commercial and Government Sector Measurement Processes

Measurement process difference	Government sector use	Commercial sector use
Support for quality standards	Many government sector measurement processes support a desired SEI CMM maturity level	Commercial organizations build measurement processes to support ISO-9000
Use of measurement information		Commercial organizations align the measurement process with one or two levels of management.
Number of metrics	Government organizations routinely use over 30 metrics in a measurement process	
Focus on the person		Commercial organizations include measures of employee satisfaction, turnover and recruiting.
Granularity		Commercial organizations measure down to very small units of software and hardware.
Using metrics to determine delivery readiness		Commercial organizations more rigorously utilize defect metrics to establish delivery dates.

government program is long, usually one to five years.

- The expected lifetime of government systems is significantly longer than commercial systems.
- Government program management must follow a number of mandated management standards, for example for risk management, earned value, cost/schedule status reporting, and others.
- While not a “procurement standard,” the CMM has become a primary source selection discriminator, and integrated into the management and measurement processes.

Similarly, the commercial sector business model must address:

- Commercial programs are funded, planned, managed and developed using internal management and engineering resources.

- Time-to-market is a key driver in program planning and tracking.
- Commercial programs must balance quality, cost and usability such that the product is economically viable.
- Commercial products tend to have a short expected life span (for example, less than two years for the Windows® operating system).

Summary. One mechanism for contrasting management between two organizations is to contrast the measurement process. The government sector tends to implement larger more robust measurement processes, to accommodate the large program scope and reporting requirements of government-related programs. The commercial sector tends to focus on people and product quality, in an effort to address time-to-market and product competition. While the two sectors have a num-

ber of similarities, they also have a larger number of differences. But despite these differences, both the government and commercial sector have embraced the measurement process as a key element in a successful project management strategy.

Pete Baxter is the software development manager at Distributive Data Systems, where he directs the development of measurement and metric products for enterprise use. For the past seven years, he has assisted numerous government and commercial organizations in planning and implementing measurement programs. He is a frequent speaker and trainer on the subject of applying measurement to systems and software engineering. His professional affiliations include SEI, ISO, IEEE, INCOSE Measurement Working Group, Practical Systems Measurement, and others.

A Balanced Scorecard Model for Technology: Putting the Measurements to Work

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Citibank has instituted a management system based on Norton and Kaplan's Balanced Scorecard¹. The Balanced Scorecard provides a method for aligning the bank's objectives from the highest level strategic visions down to the day to day operations. The alignment is top down: Business goals for several perspectives are defined to meet the corporate visions; management then establishes organizational objectives to reach these goals; and finally each employee aligns his daily activities to accomplish the organization's objectives. The key to the success of the Balanced Scorecard is a metrics program, including the scorecard, which measures and monitors the progress toward the goals in a balanced approach.

Background. Most organizations are hierarchical with delineated and compartmentalized roles and responsibilities. Information systems tend to reflect this structure with little communication between systems. The financial control accounting and general ledger systems, for example, are typically developed independently of the project management or human resources systems. Independent islands of automation have been developed in most organizations. What is needed is a bridging of the islands, that is, integration and elevation of the data, into the knowledge necessary for strategic planning and decisions. Recently, a number of techniques, such as data warehouses, decision support systems, and enterprise resource planning have addressed this integration issue. The Balanced Scorecard is another promising approach that places a strong emphasis, first on the integration of the business strategy, and second on the measurements needed to ensure the success of the strategy.

In the Balanced Scorecard, corporate strategy, business goals, and the technology that support them are holistic and integrated across all business functions. Since all of the perspectives of the business processes are interrelated and interdependent, no single function or perspective can dominate the strategy. For example, while the bottom line is always important, current returns shouldn't be emphasized at the expense of losing opportunities for long-term growth or losing key employees.

Most companies have strategic visions and plans in place, but recent surveys² have shown that

- *A clear strategic vision is not enough.* It requires communication to the entire company. When a strategic vision is in place, it must be tied to the goals and objectives of the individuals and departments concerned. Strategic plans must be broken down into objectives that have a direct relevance to the day-to-day activities of personnel.
- *Companies fail to collect the right metrics.* The right data must be gathered to provide effective measurement of objectives.
- *Companies do not identify or learn from their mistakes.* If an

objective is not attained, it must be clearly understood why, with initiatives created to modify the objective or change the approach.

The Balanced Scorecard is a management process aimed at addressing these issues. Its purpose *"...is to translate strategy into measures that uniquely communicate your vision to the organization."*³ The Balanced Scorecard defines four perspectives or business functions as shown in Figure 1. Management strategies, processes, and measurements must focus on these areas in a holistic integrated manner to achieve the business goals. As stated earlier, no single perspective should dominate the others.

The key to the successful operation of the business in the Balanced Scorecard approach is the measurement system. The underlying premise is that measurements guide and motivate, and that these measurements provide the metrics to manage effectively. You can't manage what you don't measure. Older measurement systems concentrated mainly on lagging indicators, primarily financial. Lagging indicators tend to influence short-term rather than long-term actions and views. Balanced, integrated approaches focus more on

Figure 1. Balance Scorecard perspectives.

FINANCIAL PERSPECTIVES Measures the ultimate results that the business provides to its shareholders.	CUSTOMER PERSPECTIVES Focuses on customer needs and satisfaction as well as market share.
INTERNAL PERSPECTIVES Focuses attention on the performances of the key internal processes which drive the business.	ORGANIZATION & GROWTH Directs attention to the basis of all future success – the organization's people and infrastructure.

leading indicators and the interrelation of all perspectives. The measurement of these indicators must be linked back to the business strategy to provide guidance on future directions.

Citibank Balanced Scorecard.

Citibank instituted a Balanced Scorecard methodology three years ago. High level corporate goals were set with corresponding objectives for every business, every division, and every employee in the organization. The objectives are reviewed and revised on a quarterly basis through a "management by objectives" process.

Metrics programs have been established in every division of the bank. The measurements concentrate on scorecard factors for each of the perspectives to indicate progress toward the stated goals. For example, an Information Technology organization may have a goal to reduce the costs of production support. A single metric, say labor costs of production support per month, is not good enough. Reducing the production support staff would clearly reduce the costs, but would lead to the unintended consequences of a rising backlog of service requests and decreasing customer satisfaction. Obviously, additional scorecard measurements are needed. For example, the trend in the number of defects found in production is a leading indicator of further difficulties to come, as is the service request backlog.

Unfortunately, customer satisfaction is a lagging indicator, and by the time that metric becomes available it is probably too late. Citibank management attempts to address problems like this one in a balanced and optimized approach. In this example, it might be cost-effective to attack the problem of reducing production support costs by increasing user training, or by removing defects through improved quality assurance.

Making ad hoc adjustments to the business processes is a risky business. Not all changes are good ones, and

mistakes can be costly. How is management to know which adjustments make sense? One approach is to study the measurements and trends with a decision support tool, and to make management decisions based on the trends, experience, and "gut" feeling. A better way is to incorporate the measurements into the business strategy through models and simulation to predict the outcome of proposed business changes. Relatively simple models can be constructed to simulate the impact of the changes, and more important, discover some of the unintended consequences. By testing with models and simulation, management can try several scenarios to optimize their decisions. That is, management can perform "what if" analyses with no risk, and at relatively low cost, compared to the potentially disastrous consequences of trying out new ideas in the real business world.

Balanced Scorecard Modeling.

We have recently developed some Balanced Scorecard (BSC) models to simulate the outcome of proposed changes in the Global Corporate Bank Technology division. The models were developed using *ithink*TM (v.5.1) from High Performance Systems, Inc.⁴ *Ithink* is a simple, but surprisingly powerful tool based on the strategic dynamics methodology of modeling and simulation.

The BSC approach is readily incorporated into models built with *ithink*. The *ithink* concept of sectors corresponds nicely to the four BSC perspectives, and the interdependencies of the BSC perspectives are introduced quite naturally with the tool's feedback loops. Complex models can be built from just four simple drag-and-drop constructs:

- *Stocks* (or reservoirs) represent the employee pool, funds available, work requests, or customer satisfaction, etc.
- *Flows* change the level of a stock through hiring or firing, spending, and so on.
- *Converters* provide modifications, operations, and conditions to the

flow rates and initial stock levels.

- *Connectors*, as the name implies, connect converters to stocks and flows.

*Ithink*TM provides a toolkit of buttons, sliders, counters, gauges, graphs and charts to build a "flight simulator-like" environment for controlling and displaying the results of the simulation. In essence the tool can be used to build a Sim City-like model for guiding the direction of the company. The controls for setting the initial conditions and making modifications during the runs are quite easy to use, making the models intuitively simple and ideal for non-technical users. A business manager can see the trends for key metrics, track variances, watch the company go broke, and so on as the simulation proceeds. After just a few attempts, he or she can begin to understand the impact of the changes made to the plans.

Citi BSC Model. The Citi BSC model was developed to depict several of the technology division's core processes. With the right measurements and feedback we can run realistic simulations to test various business options. The model elements include employee head counts, activities, schedules, work backlog, budgets, financials, and customer indicators. The initial pilot use of the model involved a study of employee re-assignment after the completion of Y2K tasks. Citibank has devoted significant resources to the remediation and testing of software systems to ensure Y2K compliance. Internal employees were diverted from their normal tasks and external consultants were hired to support this initiative. Now that the Y2K tasks are nearing completion, management must decide how to ramp down these resources. Alternatives might include dismissal, reassignment, retraining, or retention in a follow-up program. A BSC approach allows us to recognize the direct, as well as the indirect, sometimes unintended, consequences for each of these proposed actions. In

the year or so that employees have been diverted from their normal jobs, service request backlogs may have built up. Also portions of the business model, or at least the priorities, may have changed during the past year. These factors along with customer and employee perspectives need to be optimized in conjunction with the bottom line.

The Citi BSC model was used to test various scenarios. The specifics are unique to Citibank, but some general results can be discussed. As might be expected, the model predicted that the release of all of the Y2K workers would significantly impact our customer satisfaction levels. So, several ramp rates and/or step rates for consultant reduction and employee reassignment were examined. The completion date for Y2K certification was varied within limits, as was the rate for removing the work backlog. Other factors had little impact. "Winning the game," in this example, meant achieving the following goals simultaneously:

- Complete the Y2K tasks
- Reduce the work request backlog to an acceptable level (or at least to an acceptable negative slope in the trend)
- Increase customer satisfaction to an acceptable level (or at least to an acceptable positive slope in the trend)
- Minimize (optimize) the headcount and costs.

By adjusting the reassignment/dismissal rate, completion dates, and the tolerable levels for backlogs and customer satisfaction, it was possible to reach the goals through a number of different but balanced scenarios. Of course the headcount and costs varied quite a bit. The correct solution, the real game-winner, is determined by the division manager. He or she must decide what the acceptable levels are based on the business objectives, and thereby determine the number of employees and costs needed to achieve those levels. The decisions are still difficult to make, but at least management has some

additional guidance. Then, as the decisions and corresponding changes are made, the resulting scorecard measurements can be fed back into the model to refine it and revise the predictions.

In summary, Citibank has incorporated a BSC approach to guide the company from top to bottom. The approach defines our visions, goals, and objectives down to the day-to-day operations of every employee. A metrics system, the scorecard, has been created to monitor the progress toward the goals. The Global Corporate Bank Technology division has implemented a BSC model using the HPS *ithink* simulation package. The model incorporates key business processes and key measurements from the metrics program. Multiple scenarios are run in the simulation to test various planning options to aid in the decision making process, through the use of both leading and lagging indicators of progress toward our objectives. In the future, we hope to integrate the model directly with our metrics collection programs in order to provide continuous feedback and calibration.

1 Kaplan, Robert S., Norton, David P., September 1996; Harvard Business School Press; ISBN: 0875846513

2 Survey conducted by Renaissance Solutions Worldwide, Inc. in association with Robert Kaplan of Harvard Business School

3 Kaplan and Norton, 1996, ibid.

4 ithink™ is a product of High Performance Systems, Inc., 45 Lyme Road, Suite 200, Hanover, NH 03755

Mr. Burton is the Vice President and Chief of Systems and Software Engineering for Citibank's Global Corporate Bank Technology division. He is a newly elected member of the Board of Directors of the Software Productivity Consortium. He has previously held key technology roles in the defense industry, Department of Energy, industrial manufacturing and local government.

Dr. Cornell is the Director of Measurements, Modeling, and Simulation in Citibank's Global Corporate Bank Technology division. Prior to taking this position, he managed several international projects for the Bank and also for the U.S. government. He has been active in various aspects of modeling and simulation for many years, and at one time developed one of the world's largest modeling and simulation facilities for the DOE.

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Model-Driven System Design — A Part of Brighton

Fred Knopf, knopf@erols.com, Pete Scott, pcscott@iee.org

Introduction. The Model-Driven System Design (MDSD) Interest Group has been working diligently to characterize model-driven system design and identify strategies for the systems engineering community to migrate from present document-driven approaches. As a result of this effort, the group is helping the Modeling and Tools Technical Committee, of which we are a part, to advance the state of the practice in systems engineering through the use of COTS tools and modeling processes.

History of the MDSD Interest Group. This INCOSE interest group has been active since 1996, exploring issues and writing papers that describe advancements in the process of model-driven system design. Our 1996 paper [Baker et al, 1996] characterized MDSD as a systems engineering process in which “validation, trade studies and assessments for a requirements baseline, functional architecture and physical architecture” are “accomplished through development of increasingly detailed models.” Many issues have been open to investigation, including such important ones as integration of existing modeling techniques across varying perspectives; evaluation of new and innovative modeling approaches; and development of a taxonomy to organize these modeling processes. In the 1998 Fall Issue of INCOSE *INSIGHT*, model-driven system design was recognized as a new paradigm with two important features — improving product quality and saving money.

Since last reporting on our progress in *INSIGHT*, the MDSD Interest Group has been ambitiously pushing ahead with our research on model-driven system design. The MDSD group culminated several months of discussion and planning by hosting an MDSD panel and workshop at

the recent Ninth Annual International INCOSE Symposium in Brighton, England, held June 6-11, 1999. The remainder of this article discusses our plans to disseminate the results of these important sessions to the INCOSE community.

Recent Brighton Activity.

The MDSD group hosted the Panel entitled, “*Model-Driven System Design: Where We Are, Where We’re Going*,” on June 8, 1999, and the subsequent workshop two days later. The purpose of the panel session was to illustrate and motivate MDSD. The presentations began with a discussion of MDSD, followed by motivations from the field for using the MDSD approach, and concluded with successful state-of-the-practice uses of MDSD in the automotive industry and space exploration. The subsequent workshop had three objectives:

1. Assess the state of modeling practice among the INCOSE members, i.e., *Where does your organization stand in the MDSD spectrum?*
2. Help participants identify how they can improve the use of MDSD in their organizations, i.e., *What is the next reasonable step for your organization to take?*
3. Establish a research agenda for INCOSE in MDSD, i.e., *What should we be doing in the next 2-10 years, particularly in the next “INCOSE Year?”*

One element of topical interchange and discussion was an MDSD questionnaire that was completed by participants following the panel session. The purpose of this questionnaire was to get participants thinking in terms of MDSD and to collect MDSD information for later analysis by the interest group.

MDSD Results Dissemination.

Dissemination of results from the panel and workshop has already been initiated. As indicated below, summaries were presented to the INCOSE organizational committees prior to leaving Brighton. A summary of the panel and workshop activities is provided herein. Finally, our plans for future disclosure and circulation of all MDSD-related conference results are summarized as well.

For the INCOSE Organization.

After the workshop at the Brighton Symposium, MDSD personnel provided a Summary Report to the Modeling & Tools Technical Committee (MTTC), whose chair, Mark Sampson, in turn reported to the delegates gathered at the closing Plenary Session. He stated that, in light of our plans to generate a significant set of products, the Interest Group will be upgraded to a Working Group. A summary of our plans for the INCOSE 2000 Conference was also provided to the INCOSE Technical Board. Copies of all our documents are available, and can be requested from either of the MDSD group co-chairs, Howard Lykins and Bob Cohen.

For INSIGHT Readers — An Early Summary.

The panel session, attended by about 85 delegates, consisted of presentations by consultant Dave Oliver, Harry Crisp of the U.S. Naval Surface Warfare Center, Mike Dickerson of the NASA Jet Propulsion Laboratory, and Robert Sakretz and Ralf Hartmann of Daimler-Chrysler. Dr. Oliver set the scene by providing a model for the process of model-driven system design, and describing how the process is repeated at all tiers of decomposition. He explained that the process has parts that represent requirements,

are quite generic, and may be shared throughout an organization or a supplier network. It also has parts that are used to predict performance that are quite application dependent and will vary widely among disciplines and members of the supplier network.

Dr. Crisp presented the motivation for model-driven system design in the engineering of large, complex systems, pointing out the need for close coordination and management of the design process, the design team, the design environment, and the concurrent processes associated with the intended product. As an example, he explained the importance of MDSD for the SC21 Manning Affordability Initiative, where the objective is to support engineering trade-offs of human vs. non-human implementations of functions and tasks for next generation Navy ships.

Panelists Hartmann, Dickerson and Sakretz presented the "voice of experience," and discussed how their organizations have been using model-driven system design to enable ways of doing engineering. Mr. Hartmann explained how, in an era of shrinking budgets, his organization is using models and tools fed from a common data repository to develop satellites. A central control system allows the gradual replacement of simulation models with hardware as it becomes available, until a complete satellite exists in a simulated environment. Mr. Dickerson discussed subsystem specifications and behavioral modeling using a top down layered approach. He described how his organization uses a set of integrated tools, resulting in the replacement of document-only specifications by combinations of documents, models and database. Mr. Sakretz described how his organization is enhancing the automobile part specifications it sends out to suppliers by means of models, meanwhile producing rapid prototypes from those models. They are planning to use object-oriented system design (OOSD), with cooperation among various kinds of models, and have

identified a need for an automobile version of Universal Mark-up Language (UML).

After the presentations there was a general discussion with the attendees, covering such topics as integration technologies, version control, model fidelity, and affordability. The MDSD questionnaire was handed out and was to be completed as homework prior to the workshop. A total of 27 new volunteers signed up to work with the group.

Approximately 30 delegates attended the workshop, and after an initial briefing they were organized into four focus groups to discuss issues related to the three objectives. An extensive list of potential topics was developed by each focus group, and will be used, along with the questionnaire responses, to generate the research agenda.

For the MDSD Interest Group.

At Brighton, members of the group captured immediate observations from the MDSD panel session and made them available for the subsequent workshop two days later. Emphasis was placed on MDSD successes and shortfalls that were discussed, with suggestions or proposed actions for improvements also summarized. An ongoing effort now is to compile all the data from the panel presentations, from the questionnaires filled out after the panel session, and from the results of the workshop breakout sessions. All of the issues were identified and documented for later analysis. From these analyses, the MDSD group will provide recommendations to INCOSE for future model-driven system design initiatives. All information, including the lists of potential topics from the workshop, will be maintained on the MDSD server, and is available upon request.

For the INCOSE Community.

The end objective, of course, is to make this MDSD information available to the INCOSE membership. Plans are to incorporate these

results onto the 3SL Web Site <www.threesl.com>, with a reference link from the INCOSE site. We will develop a compendium of MDSD-related conference presentations and Workshop Report Outs for download from the web site. A synopsis of the MDSD questionnaire findings and workshop-generated topics will be produced and stored online. The questionnaire will also be listed on the web site for INCOSE members to download, complete and submit to the MDSD Interest Group for inclusion in the results database. In addition, copies of "classic" MDSD papers will be available for retrieval. Finally, the MDSD group will create model-driven system design Topic Sheets for dissemination within government and corporate organizations and at INCOSE chapter meetings.

Reference

Lloyd Baker, Paul Clemente, Bob Cohen, Larry Permenter, Byron Purves and Pete Salmon. "Foundational Concepts for Model-Driven System Design," in *INCOSE Proceedings*, 1996.

Fred Knopf is Vice President of Operations and a systems engineer with 3SL Incorporated. He is responsible for sales, application and training for the Cradle systems engineering environment. He is a member of the Model Driven System Design Interest Group and of the Washington Metropolitan Area (WMA) chapter.

Dr. Peter Scott is a systems engineer with L-3 Communications in Camden, New Jersey, having special responsibility for systems engineering process improvement. He is a member of the Model-Driven System Design Interest Group, and is Co-President of the Delaware Valley Emerging Chapter.

Supporting SE Education — The Work of the Newly Formed Educational Measurements Working Group

Peter Sydenham, Sydenham@senet.com.au

Organizations throughout the world are constantly seeking tools and techniques for improving their operational efficiency. Finding knowledgeable people with the skill set to enable changes is their primary challenge. The Educational Measurement Working Group, in recognition of the need for developing these people, was formed this past year in the belief that Systems Engineering (SE) is the discipline paving the way to best practice.

INCOSE has earned its place as a leading force in assisting organizations—commercial, government and academia—to appreciate what constitutes best practice. The technical community of INCOSE has many technical committees (TC) working on the multiplicity of issues that contribute to keep a SE operation at the “leading edge” of competitiveness.

There is general agreement that the key parameters that collectively work to support integrated SE best practice are processes, tools, and people. Inspection of the long list of TCs, and their working groups (WG) and interest groups (IG), will show a preponderance of activities supporting processes and tools, but less support for people issues. One of the key people issues is staff development.

Since the formation of INCOSE, it has been well recognized that the education of people who work on the SE components of technical projects has considerable importance. It is also known that well-formed leadership is essential. A problem facing INCOSE leadership was how our organization could make a worthy contribution in this particular domain.

Several early initiatives were made by the INCOSE Technical Commu-

nity to broach how to support the educational aspect of the systems engineer. An approach was needed that should satisfy the needs of all stakeholders involved—students, employers and educators. For several reasons, difficulty existed in establishing a technical support activity for this area.

One approach is for INCOSE to join the existing plethora of course accreditation schemes. We, too, could issue guidelines to use by those who are considering granting accreditation to educational institutions putting forth SE courses. This idea was floated several times over three years, but failed to gain support, perhaps indicating that it was not appropriate for INCOSE to do at this time.

The issue of INCOSE becoming actively involved in accreditation came to a head at the July 1998 Vancouver symposium. A formal attempt to implement a look-alike accreditation scheme was proposed at the Education & Research Technical Committee meeting. It floundered. Fortunately, at that time, circumstances were favorable for a new and exciting approach to emerge. As the result of a series of meetings held during the conference, an Educational Measurements Working Group (EMWG) was recommended, being formally established in October 1998. It met for the first time at the January 1999 International Workshop. A series of meetings made good progress on a difficult issue.

The new approach was to recognize that the issue at stake is not about giving pontifical approval of programs, but about developing means to allow all stakeholders concerned with the formation of SE staff to be part of a sound self-

improvement process. The concept of an Educational Capability Maturity Model (ECCM)—along the lines of the SEI CMM products—emerged, provided it was developed and used as a model for self improvement, not as a de facto standard that mimics accreditation schemes. However, the team investigations were rising up a steep learning curve, the maturity model approach soon being seen as not providing an holistic enough solution. This will be discussed later.

In order to develop a suitable model, there has to be a sound and succinct mission. The mission statement that working group agreed upon sums up the directions of the EMWG well: *Assist in making Systems Engineering education a proven, value-adding activity that matures in a systemic manner.* This mission is the prime preoccupation for EMWG activity. Naturally, many sub-issues will emerge in support of this mission, for example, subject material, curriculum, terms, and more. But, they will not be allowed to dominate the high level mission.

Next, there has to be an effective group operation that can make efficient use of volunteer contributions. This is now in place and is based on a robust web site linked to the Technical Community of INCOSE (see <http://www.incose.org/emwg/index/htm>). This is the data repository of the group, and documents:

- Charter
- Objectives
- Targeted Products
- Membership lists
- Inputs and Outputs
- Written Material of interest
- Relevant Published Papers
- Up-coming Meetings
- Meeting Records
- Chat board.
- Contact Information

To carry out its work, the EMWG makes use of the two main INCOSE events held each year (annual symposia and international workshops), plus email. To save space, this report does not give all member contact information—they are identified on the EMWG web site, or in the

meeting reports.

After the inaugural meeting of the EMWG in January 1999, the elements of a sound work plan have gradually become clear as the concepts needed to implement the mission are explored. In summary (more detail can be found in the web site sections), the first step was to review the reports, published statements, administrative structure, and web-site activity that had taken place since July 1998. Feedback supported our goals as being appropriate and desirable. To ensure the work to be carried out has a sound basis and uses the member's time well, a group providing good representation of stakeholder interests debated several key issues:

- Is the mission correct?
- Why will the work be valuable?
- Who will appreciate the products?
- How will EMWG know the products are valuable?
- Why is EMWG qualified to develop this contribution?
- What is the place of autonomy of educational excellence?
- What is the scope of the EMWG work?
- Who will ensure self-assessments will be sound?
- What terminology should be used?
- What is being assessed?
- How will EMWG implement the Mission?

These discussions paved the way forward as the result of:

- Defining the task to be accomplished
- Establishing its system limits
- Externalizing its main subsystem elements
- Appreciating the interactions taking place between the technical, political, commercial, and societal domains of this complex system.

Increasingly it became clear that the maturity model approach alone is not an adequate means to meet the mission and objectives. Its thrust is on maturing the capability of the

supplier to carry out certain tasks. It does not address the interaction of all stakeholder groups involved.

The methodology used to meet our mission needs to ensure the right product is being produced, as well as having it developed by capable people and process. With this important broader viewpoint realized, EMWG work after the workshop headed toward a more fundamental "systems thinking" viewpoint.

Instead of concentrating on third party authentication as the principle means of influencing adequacy in provision, it is now seen to be more appropriate to develop a methodology for educational development that treats the need as one of developing sound operational aspects for delivery of an appropriate service. Authentication, curriculum, metrics, process, integration, and the many other SE practice parameters all become normal elements of the methodology, but do not drive it.

Three critical sub-systems have been identified; details are available on the EMWG web site.

ConOps: A Concept of Operations (ConOps), which models how a capable systems engineers is formed, is the key to success. A draft ConOps for the Systems Engineer Educational Environment (SEEE) has been prepared. It models the necessary parts of the system and how they integrate. It describes how the novice systems engineer matures through several levels of capability. It is based on sound educational theory and assessment methodology.

Capable Systems Engineer Model: Several large SE organizations have pooled their proprietary definitions and parameters of this model person. These have been embedded into a draft "Systems Engineer Competency Profile." The work of the "SE Skills and Taxonomy" Team, formed by INCOS's Corporate Advisory Board, has many elements in common with this modeling. The two activities are now being compared.

Instructional System Development Model:

A third element needed is an Instructional System Development Model. This provides, in educational delivery terms, a generic SE process for understanding how instruction is developed and delivered. Since this year's symposium, our work is integrating these subsystems parts to form a systemic methodology for the formation of capable systems engineers, which is our mission. Notable features of the "operational" methodology being developed are:

- Allows for life long education of staff as they mature in their career starting out as a detailed engineer and rising to the highest level, the Reflective SE Practitioner.
- Incorporates the needs of employers, students, and educators as a system, maturing with all co-operating throughout the several cycles needed.
- Includes measures of effectiveness, and related subordinate lower level metrics, at key stages of the process. This facilitates authentication on a sound and comparable foundation.
- Allows self-assessment to be used, thus retaining the benefits of the maturity model approach.
- Incorporates reporting on an ongoing basis
- Incorporates many soft system factors overlooked in conventional educational formation of engineers.
- Is logical in its approach and is based on the scholarship of systems development, educational development and assessment theory and practice.

It is envisaged that the EMWG will release draft documents of the above three products, plus a description of the methodology, for comment shortly after the January 2000 International Workshop.

Integration of these parts into a draft methodology is scheduled for release around July 2000. From then

on the documentation will pass to the Technical Board for endorsement as the next step to possibly becoming an official INCOSE position.

Is it too much to suggest that the work of the EMWG will spark new directions in educational development at large? So far, work is proceeding well due to the great cooperation and hard work of its membership. Fortunately, the response to the call to form the EMWG was very strong from industry, academia, and government. The new approach obviously has appeal, and membership of the

EMWG is increasing.

Looking back, it can be identified that the continued use of systems thinking is making the difference here — but that is hardly surprising for an INCOSE group!

Peter Sydenham is chair of the INCOSE Education Measurement Working Group (EMWG). He has BE (Hons), ME, PhD and DSc degrees in electronic engineering and measurement systems. Academic leadership posts he has held include Head of School and Director/founder of several research centers. He has undertaken numerous consultancies with industry, and supervised many postgraduate projects in Measurement and Whole of Life Systems Engineering. He currently shares his time as Professor of

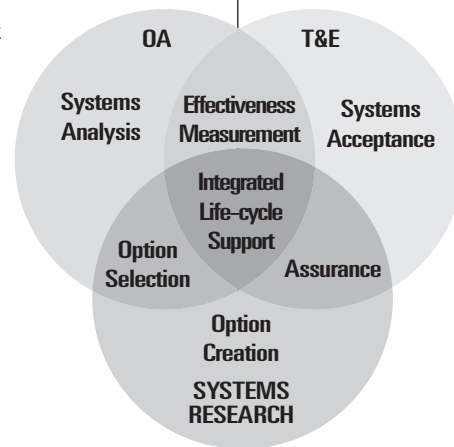
Systems Test and Evaluation, University of South Australia, with the Defence Engineering Group, University College London.

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Systems Engineering in the Commercial Air Transport Domain

Greg Mathers, greg.mathers@boeing.com

Background. The Joint Commercial Aircraft Working Group (JCAWG) consists of members from INCOSE, other professional societies, major aircraft manufacturers, regulatory agencies, suppliers, and other companies in the commercial aircraft domain. Geographical representation of our participating members includes North and South America and Europe.

Aircraft and air transportation systems are systems with their own unique functions and drivers. The JCAWG is dedicated to the principle that it can provide a unifying force to create a framework within which existing systems practices can reside, and can augment these practices with sound systems engineering principles to create quality air transportation systems.

The manufacturing and operations of aircraft within the Commercial Air Transport Domain (CATD) is an international endeavor resulting in global partnerships. These global partnerships demand a truly international framework to establish common principles, processes, and terminology to enable many partners to work together in creating cost-effective quality products.

Current Status. The JCAWG is in the formative stage of development. Its charter, vision, near-term goals and first product have just been established. The JCAWG operates under the auspices of the Systems Engineering Applications Technical Committee (SEATC) of INCOSE. The Seattle Metropolitan Chapter of INCOSE is the current chapter sponsor of the JCAWG.

JCAWG's purpose is to define potential benefits of applying system engineering processes, methods and tools to the Commercial Air Transport Domain (CATD); to provide system

engineering professional guidance, influence and leadership in defining an action strategy for the application of system engineering in this area; and to lead the implementation of the strategy so that the potential benefits can be achieved. To meet our goals, we have proposed the following objectives:

1. Establish a forum and focus for commercial aircraft systems engineering,
2. Prepare a set of system engineering "operational" guidelines for the commercial aircraft domain,
3. Produce a Guidelines Document in concert with established guidelines (EIA 632, ARP4754, IEEE Standard 1220, and ISO Standard 15288),
4. Sponsor technical papers and information exchange focused on the commercial aircraft domain,
5. Develop and maintain a professional set of literature for the commercial aircraft systems engineering domain.

Additional information regarding the JCAWG forum, guidelines, guidelines document, and emerging agreements are discussed below.

The JCAWG Forum. The forum has been founded to establish and document standard SE practices within the CATD. The forum currently is conducted by weekly conference calls, and is supplemented by meetings at regional and international conferences as well as numerous "off-line" conversations and e-mail. This forum has established our current goals and continuously reviews and updates our plans towards achieving them.

System Engineering Operational Guidelines. The JCAWG has identified existing and proposed

guidelines that are applicable to the CATD. We are tailoring existing guidelines where applicable, and supplementing those guidelines with an additional one which will help cover areas identified as needing enhancement as well as areas of omission.

Guidelines Document. JCAWG is chairing the development of a supplemental guideline for the Commercial Aircraft Transport Domain under the title of "Guidelines for the Practice of Systems Engineering in the Commercial Aircraft Domain." The primary purpose of this document is to span the gap between the ANSI/EIA standard and the other guidelines for the aircraft industry. To develop a consensus of concepts, terms and abstractions developed to eliminate misunderstandings between manufacturers, suppliers, regulators, and purchasers; to facilitate product interchangeability and improvement; and to assist in the production or selection of the proper product in a minimum amount of time. As with earlier guidelines and standards, this document is being jointly developed by professional societies, aircraft manufacturers, suppliers, regulators, and other organizations representing the CATD. The current plan calls for a distribution and review of the first draft by the end of 1999. This document provides an overview of the systems engineering process, tools and methods as they apply to the CATD.

Collaborative Agreement. Systems engineering (SE) principles are also of interest to other CATD stakeholders. To further SE principles, the JCAWG is establishing domain specific working relationships among the regulatory agencies, professional organizations, and manufacturers currently involved in CATD. Toward this end, a draft collaborative working agreement has been developed and is being circulated to current and proposed participants. This proposed agreement is intended to

permit the broad based perspectives to be shared within the forum, and transcribed into the guidelines document to reflect the total systems engineering aspects of CATD. This broad-based perspective ensures that all aspects of SE are addressed in the guidelines.

The guiding principles of operation for the guidelines are based on the understanding that all participating organizations are considered equal partners. Approval of the guidelines will require a unanimous vote. Although initial contacts have been made with many organizations, formal agreements have not yet been signed. These agreements are a top priority item for the near term. Although these contacts are in the preliminary stage, we are confident that we have identified a critical set of participants in both the SE world and the aviation world to put the project together.

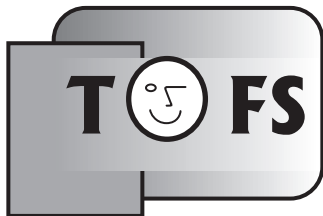
The Future. There are significant opportunities to expand SE practices in CATD. The competitive environment of CATD and the complex nature of aircraft design, construction, operations, and maintenance make commercial aircraft prime candidates for the application of systems engineering. In particular, systems engineering is uniquely suited to the evaluation of advanced technologies for possible introduction into commercial aircraft design as well as later in the aircraft's life cycle. The JCAWG has taken initial steps to develop and document domain specific SE practices for the CATD. The "Guidelines for the Practice of Systems Engineering in the Commercial Aircraft Domain" document will require several years of intensive effort before compilation, review and approval are achieved. Subsequent projects to support our primary goals have yet to be developed. The

JCAWG is seeking input from all interested parties to help formulate its future.

Membership. We are actively seeking additional members who support our goals. Persons who wish to participate in the working group should contact:

- Greg Mathers, (425) 717-1020 or greg.mathers@boeing.com
- Morgan McCartor, mary.mccartor@boeing.com

***Greg Mathers** is currently a Senior Systems Engineer with the Boeing Commercial Airplane Group. In past career positions, Greg has worked as a Systems Engineering Supervisor for Lockheed Shipbuilding and was a Senior Systems Engineer with the Boeing Defense and Space Group. Currently, Greg is Chair of the INCOSE Joint Commercial Aircraft Working Group.*



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INCOSE Position on Capability Models and the Capability Maturity Model Integration (CMMI) Effort

April 18, 1999

Principles. INCOSE supports the concept of integrating capability models such as the Electronic Industries Alliance Interim Standard (EIA/IS) 731 and SW-CMM (Software the Capability Maturity Model for Software (SW-CMM)) ("CMMI source models") to eliminate apparent duplication and possible conflicting guidance from each.

Purposes. The purposes of capability models should be

1. to enable and guide internal process improvement,
2. to enable cost-effective assessment of progress in process improvement, and
3. to provide a framework for common discussion about processes and process improvement across the system and software development industry and its customers.

Use. INCOSE discourages the use of results of capability model assessments as a means of selecting suppliers. Assessment results should be used for internal process improvement guidance. Use of these results for competition may lead to distortion of the purpose of assessments. INCOSE approves of the use of practices in capability models as a basis for questions to potential offerors in requests for proposal.

Process. INCOSE recognizes that the CMMI (Capability Maturity Model-Integrated) source models have achieved the status of "de facto" standards for assessing process maturity, and thereby urges that a broad consensus-based process be used for model development and review. In particular, INCOSE urges that

preparation and review of the models should include participation of members in many countries and from the commercial sector, especially those with experience in continuous models and systems engineering assessments. It is also important to leave adequate time for review.

Assessments. INCOSE recognizes that not all organizations need, want, or can afford a full assessment similar to the SW-CMM's CapabilityMM-Based Assessment Appraisal for Internal Process Improvement (CBA-IPI) method. Other, less formal methods are not only appropriate but necessary to meet the needs of the broad user community. Variations of assessment methods that should be addressed include full internal assessment (CBA-IPI-like), interview-based assessments, document-based "quick looks," questionnaire-based appraisals, and educational "facilitated discussion" assessments that launch a process improvement effort. Importance must be placed on balancing data usefulness and validity with the cost to obtain the data.

Generic Attributes. INCOSE believes the generic attributes (process effectiveness and product value) in EIA/IS 731 must be addressed in CMMI. The generic attributes were added to ensure that business needs can drive the process maturity efforts. If, as a result of a process, documents are being produced that are not useful, the process, however mature, is broken. While industry's history of dealing with process effectiveness and product value is short, INCOSE believes that CMMI

should take steps to start building up such a history. This cannot happen if these generic attributes are left out of the CMMI.

Advanced practices. Advanced practices were included in EIA/IS 731 after careful consideration. The SW-CMM also includes the equivalent of advanced practices, included in related KPAs (key process areas (KPAs) that are invoked at higher maturity levels. INCOSE believes that advanced practices are an important part of process improvement, and should have a defined place in CMMI. Specific practices at Level 1 should be limited to the basic practices necessary to demonstrate performance of the process area.

Representations. INCOSE supports the development of both continuous and staged representations of the CMMI. A substantial constituency has invested in each representation, and neither should be excluded from the CMMI. The two representations should be as similar in content as possible, varying only in "look and feel." Assessment of a common process area using both staged and continuous representations should lead to similar results and guidance for improvement.

Informative material. INCOSE believes that tutorial information is necessary, particular to newer users of CMM models. INCOSE supports clarification of which material is normative and which is informative. Normative material should be that which must be met, to demonstrate progress in process improvement.

continued on following page

Vocabulary. The CMMI framework upon which the CMMI models were based defined the content of the pieces but did not define a common vocabulary between the two representations: i.e. the continuous representation uses “themes” and “practices,” where the staged representation uses “goals” and “activities.” INCOSE believes that there should be a single vocabulary used for the two representations, and they should have as common a visual appearance as possible, to emphasize the common basis of the two representations.

Incremental development.

INCOSE supports incremental development and review of the CMMI product suite. First combining the two capability models with the largest constituency (the SW-CMM and EIA/IS 731) with due consideration for later adding

information from the IPD-CMM and other models is a sensible risk mitigation strategy. INCOSE recognizes that additional review steps and less-than-complete products for review can be considered to impose an additional burden on reviewers compared to reviewing final products once. However, this burden is overshadowed by the opportunity to influence core aspects of the CMMI product suite by reviewing in-work products.

Ownership. INCOSE believes that ownership of the CMMI models would should not necessarily be held by a single entity. Ownership arrangements must be created in concert with the current owners of the source models, including the Software Engineering Institute, EIA and INCOSE. These arrangements must be spelled out in an operating plan which provides:

- a. A global and domain-balanced point of view
- b. Long term stability
- c. A means of responding to inquiries about the models
- d. A method to collect suggestions for improvement and update the models periodically to incorporate them
- e. Methods to provide services under contract to users when requested. Services should be available from a variety of qualified sources. Qualification methods must be agreed upon by all parties.
- f. Methods for distribution of CMMI knowledge to the community of users, assessors, and trainers in a cost-effective manner.

In particular, a memorandum of agreement must be signed with INCOSE regarding maintenance of the models and training, and certification of lead assessors.

Advances in Commercial Product Development: Lessons for INCOSE Systems Engineering

Elliot Axelband, R.B. Campbell, Don Clausing

Commercial product development has evolved very rapidly in the last 20 years, driven by intense global competition. Unconstrained by external rigidities, such as public sector bid and contract requirements, commercial companies have been free, indeed forced, to innovate in the area of product development. Performance metrics have improved greatly, especially in the areas of time-to-market and overall research and development effectiveness.

Many of the advances in commercial product development have come in embedded systems engineering. Since they often have not been explicitly labeled as system engineering,

they have tended to be overlooked by system architects and engineers working in the public sector. These advances include: end-to-end highly concurrent and integrated product development processes, use of spiral as opposed to waterfall processes, integration of full service design partners into systems design, and close coupling between marketing and technology, frequently mediated by the system architect. Especially noteworthy is the application of robust design, which rapidly improves reliability. In the industries that are strongly constrained by external rigidities, the emphasis is on the quantification of reliability, rather

than on its improvement. This is indicative of the problems in these industries — excellent engineering producing good answers to the wrong questions.

In the next issue of *INSIGHT* the authors will present a complete article that compares commercial product development and INCOSE-style systems engineering. This will include thoughts on the future of INCOSE.

Introduction of Systems Engineering as a Change Process

Dr. Michael Ali, michael.ali@appl.ge.com

Introduction. The goal of every commercial organization is to bring the right products to market, at the right time, at the right price, with the highest possible quality. Achieving this goal requires a systems engineering approach to make the right trade-offs between simultaneous, and often conflicting, product demands from customers, engineering, sales, finance, marketing, service, and federal agencies. The introduction of systems engineering into an organization requires a strategy based on an understanding of the change process. The change process consists of the steps in Table 1. Successful implementation of the process requires that all of the steps be addressed, not that they be followed in the order given. We discuss the steps in more detail below.

I. Setup
A. Establish the urgent need
B. Build the core team
C. Develop a strategy
II. Execute
A. Deliver short-term wins
B. Align processes
C. Align people and policies
III. Follow-up

Table 1. Change process steps

I. Setup

A. Establish the urgent need. The enemy of change is complacency. Without a well-understood, well-articulated, and urgent need for systems engineering, any plan for its introduction will fail.

B. Build the core team. The core team has the power to develop and implement the change strategy. Success requires the involvement of the CEO or one or more of his/her direct reports. In addition, those designated to become the system engineers for the organization, as well as their managers, must be on the team.

C. Develop a strategy. Most businesses are actively pursuing major initiatives in Total Quality Management, Six Sigma, globalization, etc. Rather than introduce systems engineering as a separate initiative, it should be integrated with these existing corporate initiatives.

II. Execute

A. Deliver short-term results. Change processes are long and difficult. Without evidence of success, the effort will fail. While it is important to stay focussed on the long-term objectives, short-term wins are essential. Anecdotal stories work as well as hard metrics.

B. Align processes. Existing processes must encourage and support the use of systems engineering tools and techniques. Formal and informal design reviews must check for evidence of systems thinking. New product introduction “tollgate” reviews should require systems-level analyses.

C. Align people and policies. Aligning people means constantly communicating the vision for systems engineering and the implementation strategy. A variety of communication channels are needed: lectures, training sessions, employee meetings, mentoring, consulting, etc. Human resource policies must also be aligned—ideally personnel evaluations would include a “systems thinking” component.

III. Follow-up

Fundamental changes to organizational culture cannot be accomplished overnight, or even after one year. Efforts have to be on going. The strategy has to evolve to keep up with the realities of implementation, and also to keep

the message fresh. The ultimate test is to assume that if the core team disappeared, would the use of systems engineering continue?

Summary

Reduced time-to-market, increasing product complexity, and higher quality requirements make using a systems engineering approach to product development an imperative for commercial organizations. A strategy for the introduction of systems engineering must fulfill the requirements of the change process to succeed.

Reference:

Kotter, John P., *Leading Change*. Harvard Business School Press, 1996.

Dr. Michael Ali is the Manager for Systems and Reliability Engineering at GE Appliances in Louisville, KY.

Electro-Motive
ad (paper)

Working Groups

Measurement Working Group Measures Its Progress

Garry Roedler, garry.j.roedler@lmco.com, Don Gantzer, don.ctr.gantzer@faa.gov, Ken Stranc, kjstranc@tasc.com

The Measurement Working Group (MWG) has held two meetings since February to measure our progress against our plans. Thanks to the hard work of many of its members, the MWG has continued to make significant progress across many projects.

The following is an update of the status and near-term plans of the MWG activities.

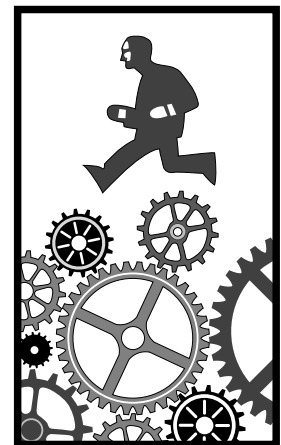
- **MWG Brochure.** The new MWG brochure has been approved and is being distributed.
 - **Practical System Measurement (PSysM) Tutorial.** Garry Roedler and Don Gantzer conducted a prototype session of the PSysM tutorial at INCOSE '99. The tutorial, patterned after the PSM (Practical Software Measurement) course, describes a standardized process for implementing systems engineering measurements for projects. It includes a draft of the revised set of measurement descriptions provided by the MWG.
 - **Practical Systems Measurement Guidebook.** The MWG has been leading an effort to extend the Practical Software Measurement guidebook to systems engineering by developing a consolidated set of guidelines for software and systems measurement processes. A draft for review will be released early this summer, and it is anticipated that the updated version will be released in the fall. Garry Roedler, Ken Stranc, Don Gantzer, Bruce Allgood, and Sarah Sheard provided major inputs at a
- weeklong workshop in April.
 - **Emerging SE standards.** We are continuing to assess the implications of recent standards to determine their implications on measurement (Ron Kohl on EIA 632 and Don Gantzer on EIA/IS 731).
 - **CMMI and Measurement.** LTC Joe Jarzombek, USAF/STSC, has been instrumental in establishing the Measurement & Analysis Process Area within the CMMI. He has also developed an associated Measurement Plan template incorporating input from members of the MWG.
 - **FAQs.** Ken Stranc continues to provide INCOSE members with measurement FAQs in every issue of *INSIGHT*. In addition, he has recently updated the Master List of Measurement FAQs on the MWG web site at http://www.distributive.com/INCOSE_MWG/FAQ.htm.
 - **Measurement Tools Survey.** The MWG has developed a survey for measurement tools. We are now receiving results and expect to have a summary prepared later this year (Peter Baxter, Chris Miller).
 - **Measurement Information System Tool (MIST).** Bill Farr released Version 1.0 of MIST at INCOSE '99. This is an on-line measurement reference catalog developed in collaboration with the Naval Surface Warfare Center (NSWC). MIST is complimentary with the PSM INSIGHT tool,

which will be updated after the PSysM Guide is released.

- **Effective Reporting and Use of Measurement Information.** The MWG reviewed and approved a plan for this new project, which will develop guidance on communicating measurement information (Ken Stranc).
- **Cooperation with other INCOSE groups.** We have established and are continuing to pursue interfaces with other INCOSE groups whose work is related to measurement.
- **Other Candidate Projects Under Consideration.**
 - 1) Effective Assessment of a Measurement Process and
 - 2) Small Project Measurement Guidance.

For more information on MWG projects and products, see the MWG web site at:

http://www.distributive.com/INCOSE_MWG/Home.html.



Measurement: Frequently Asked Questions

Ken Stranc, kjstranc@tasc.com

Question: How do I justify to my customer or boss the additional cost of measurement on my project?

Point out that measurement gives you a quantifiable basis for understanding and managing project risks, problems, and improvements.

Measurement Provides an Effective Risk Management Tool. Risks represent “unknowns” about a project. The more aspects of your project you can quantify through measurement, the more you really know and understand about the project, and therefore, the better your management decisions. Measurement helps you to identify risks and often points the way toward strategies that allow you to manage the risks most effectively. It helps reduce the number and size of the “unknowns,” thus enabling your project to perform closer to its plan. The benefit you receive is the avoidance of unexpected costs, schedule delays, and quality problems due to surprises. To drive this point home, prepare an example that shows an assessment of risks with and without the quantification of the risks and potential mitigation reduction techniques. Use this example to show that decision-makers have a much better ability to recognize the impact of the risks and to take the best course of action to manage them when their decisions are supported with quantitative information. In the example, show what the cost of an unmitigated high priority risk could be and explain that measurement could help avoid that cost. When you consider cost avoidance over multiple risks, the cost avoidance gained through measurement, paired with good decision making, can be very significant.

Measurement Provides an Effective Problem Assessment Tool. Not all risks can be eliminated or have their impacts reduced to zero. Thus, it is a fact of life that some problems will occur and we need to learn effective

ways to manage them. When problems occur, it is important to be able to quantitatively assess their magnitude. Measurement of factors related to the problem and its environment will help you to assess the problem’s magnitude and to evaluate potential solutions to the problem. By identifying the types of problems that have occurred most often in the past, it is possible to identify early on which data to collect so that you have measures available that address the most likely project problems. Then, show that these measures will help management make more timely and make better decisions when these problems do arise. Look for an example in your organization where a good solution to a problem was developed quickly as a result of having the right information.

Measurement Provides an Effective Project, Product, and Process Management and Improvement Tool. You can also justify the cost of measurement by showing how invaluable it is in planning, monitoring, and improving any project, process, or product. Measurement is necessary to support good estimation of expected cost, schedule, and quality results. Feasible plans can only be established when there is some basis on which to build and validate the estimates. The historical data from past projects, products, and processes provide that basis. As the plans are executed, measurement then serves to provide an indication of whether the plans are being met through comparison of actual against plan. These comparisons help determine where improvement is warranted. Then, by continuing to measure, you can quantify the impacts of the changes you are making in order to determine whether they are having the desired improvement effect. During your initial and subsequent planning efforts you can examine measures collected on similar projects in order to improve your estimates and produce more realistic

plans. From an improvement perspective, therefore, the benefits of measurement include better-planned projects, more efficient processes, and higher quality products.

Question: How does the role of measurement change over the life of a system?

The measures you use to help you control your systems engineering project are selected to address specific issues. Just as the issues change during the life of your project, so should the measures you use to gain insight into those issues. For example, at the beginning of a development cycle, you will certainly be interested in tracking the number of system requirements. You are also interested in tracking the volatility of the requirements including the number of unknown or unspecified requirements remaining in the requirements documents as you converge on a baseline. During design you will still want to track requirements volatility, but you will also be interested in measures related to your design, such as the number of components in the system, the number of interfaces, and other measures related to system size or performance. During the build phase you will likely be focused on measuring technical characteristics such as the size, weight, speed, etc. of the elements you are building to ensure that they meet the stated requirements. When integrating and testing, you will be interested in measuring the number and severity of defects. Once the system is operational, you will want to track system performance in terms of service availability, number of failures, time to repair, and others. In contrast to the measures directed at particular system phases, there are also measures that will be used continuously over the life of the system, although they may be modified slightly to satisfy the specific needs of each life cycle phase. These are generally indicators of resource usage, schedules, and progress.

Tools Database Working Group

Bill McMullen, w-mcmullen@raytheon.com

The Tools Database Working Group has added over 400 tools to the database since last January, and currently lists over 1,200 Commercial Off-the-Shelf (COTS) and Government Off-the-Shelf (GOTS) tools of interest to systems engineers. These tools are listed alphabetically by tool name and by tool vendor. However, newer navigation strategies are being generated.

Navigation by Process Taxonomy

To facilitate easier navigation of the database and promote systems engineering processes, an effort was initiated to map the EIA 632 process to the tools database. At the symposium in Brighton, work was also started on an IEEE 1220 process to tools mapping.

New Tool Surveys

Through a collaborative effort with the Measurement Working Group at the International Workshop this past January, a Measurement Tool survey was constructed and distributed to nine different COTS vendors. Responses have been formatted for the INCOSE web pages and a summary page was generated.

Updates to the requirements management (RM) and the systems architecture (SA) responses have also been made with a new tool (QSSrequireit) and revised inputs from the previous vendors.

If you have a tool to be added to the database or an idea on how to ease navigation, then please contact the WG chair below.

The URL for the WG is www.incose.org/tools/index.html.

For more information contact Bill McMullen w-mcmullen@raytheon.com, or 972-344-5781.

Resource Management Working Group (RMWG)

Ted Dolton, alanjoanne@aol.com

The Resource Management Working Group (RMWG) is a Working Group of the INCOSE Systems Engineering Applications Technical Committee. The INCOSE San Francisco Bay Area Chapter is currently the focal point of the RMWG; however, participation is invited from anywhere within INCOSE.

The RMWG works to find new applications areas for systems engineering in public sector domains that conserve, help understand, and manage resources, both natural and human. The RMWG works with jurisdictions and citizen groups, on local, state or national levels, in understanding their requirements and issues, and helps them utilize systems engineering processes in meeting their goals.

In the past, RMWG has done a variety of projects: developing a specification for a new school for hearing-impaired children; working with the U.S. Forest Service on wilderness management; and working with local groups in the San Francisco Bay Area on watershed management. Current projects include working with a non-profit agency in creating a systems approach to developing affordable housing; and with a central organization whose mission is to help a variety of non-profit agencies in Silicon Valley.

Key lessons learned in working with these organizations are:

1. The need to identify stakeholders and to get them engaged;
2. Using a systems process to address stakeholder interests and integrate them with the solution-discovery process;

3. Recognizing differences in language/lexicon between systems engineers and people in resource, civic and non-governmental organizations;
4. Getting customers, clients or users to understand that systems need a unique approach;
5. Introducing SE gently, sometimes invisibly;
6. Sometimes working within a customer's existing system, and/or complementing it; and
7. Not letting complexity be a barrier to accomplishing the project.

In the affordable housing arena we have worked with a local non-profit agency to become familiar with and utilize the standard systems engineering methodologies that are in EIA 632 and the INCOSE Handbook in managing affordable housing development projects. In the more general area of working with non-profit organizations, we have introduced the standard SE methodology and helped these agencies to function more productively. Teams are formed by the central organization, and they are assigned to a non-profit agency that wants to solve its problems and develop organizational and process changes. These teams, as well as non-profit organizations, benefit by the SE methodology. Such an approach provides a clear way to identify and understand the problem, and understand the requirements, before proposing and designing solutions.

For additional information, or to participate, contact Ted Dolton, 650-321-5950, e-mail: alanjoanne@aol.com.

News from Chapters

INCOSE Gourmet Wine Getaway

James A. Sanchez, gmonteros@earthlink.net

Join the INCOSE on an exclusive gourmet wine week-end, tentatively planned for October 22-24, 1999. Discover how systems engineering applies to the wine making process and have fun at the same time! A product of this tour will be a paper to be submitted for the INCOSE Symposium in the year 2000.

This is a high-quality tour customized to the needs and specifications of INCOSE. Viticulture and enology is a fast-changing business in which innovation is a constant factor. Vineyards in Santa Barbara and San Luis Obispo counties in California are involved in constant learning from experimentation. Grafting techniques, row spacing, drip systems, low water use, integrated pest management, where to plant varietals, micro climates, cutting-edge knowledge of botany, chemistry, geography and hydrology are areas in flux. Marketing, management, government regulations, legal technicalities and a strong aesthetic component play key roles.

The all-inclusive week-end package begins on Friday at 3:00 p.m. from the deluxe Santa Maria Hilton, near Santa Barbara. Set your palate to be wine'd and dined in the heart of California's Central Coast Wine Region. Peter Kerr, an Irishman with a Masters in Science from Dublin University, will accompany the INCOSE group on all winery visits, tastings and private dinners with the wine-makers. With over 17 years as a wine consultant, Peter's mix of accurate information and his low-key, non-intimidating style is perfect to begin the introduction to California's undiscovered wine country. His expertise will assist in answering questions and gaining insights into the wine-making

process.

Each dinner showcases an individual winery and its products. Mr. Kerr, a chef and a wine-maker, will create a four to five course meal, with each food course perfectly matched to a wine. INCOSE participants will be joined by Peter Kerr and the wine maker for an evening of insight and education. Learn about the history and background of the winery and the winemaking organization, concepts, methods and information networks of each particular wine maker. This is your chance to get "up-close and personal" with the man or woman behind the wines.

The package includes hotel, taxes, two dinners, one catered lunch, one breakfast, one brunch, four to five winery visits, and transportation to and from hotel to wineries. The tentative price of \$495 (U.S.) per person, based on 20 people. Interested participants from INCOSE members, friends and family should contact Gloria Ann Monteros at (310) 676-6550, or at GMonteros@earthlink.net. Early planning for how many are interested will help us to schedule quality time with owners and wine makers.

Midwest Gateway Chapter News

John Hulsman, Jr., Secretary
john.r.hulsman-jr@boeing.com

We bade a mid-western winter farewell with a meeting to develop new ideas for improving the chapter. As a result of the meeting, the chapter will plan events farther in advance to give the members additional time to work the events into their schedules. The chapter will also increase promotion of INCOSE to non-members. Bill Bezdek, the Program Chair, has accepted the challenge and has

done an outstanding job of planning programs for the remainder of this year and well into next year.

Noted aviation author Bill Sweetman was the featured speaker at the April dinner meeting. His chosen topic was Top Ten Headlines 2000-2005. Based on years of covering the aerospace industry, he predicted:

1. Pentagon cuts back on Joint strike Fighter,
2. Kosovo war reports recommend sweeping changes,
3. U.S. Air & Space Force established,
4. Black programs exceeded \$300 billion,
5. Planes without pilots set for wide use after 2010,
6. Commercial launchers set to scoop market,
7. NASA to be split up,
8. Airbus overtakes Boeing,
9. Major U.S. airlines face flat profits and fresh competition, and
10. Wealthy boomers take to the skies.

As with his previous presentations at St. Louis, this one was interesting and entertaining, although his prediction concerning Airbus wasn't popular with the Boeing partisans in the audience.

Joe Dobronski was the featured speaker at the May dinner meeting. Joe shared his experiences as an experimental test pilot during his career at McDonnell Aircraft. In addition to discussing the well known programs (Banshee, Demon, Voodoo, Phantom II, Eagle and Hornet), he also discussed the lesser known prototypes including a four-engine business jet, a short takeoff and landing turboprop transport, and several helicopters. The pictures alone were worth the price of admission.

The April and May meetings were collaborations with the St. Louis Section of the American Institute of Aeronautics and Astronautics and Society of Flight Test Engineers, respectively. INCOSE literature was prominently displayed at the entrance desks.

On a personnel note, Bob Scheurer, current Past President of the Midwest Gateway Chapter, recently took a job at Ralston Purina. It's "just down the road a ways" from his former employer (Boeing, nee McDonnell Douglas), and he will continue on the chapter board and remain involved in the chapter. He's already lobbying to have board meetings at his new employer. (I can't wait to see what kind of snacks they provide.) His new e-mail address is bscheure@ralston.com.

San Francisco Bay Area

Dorothy McKinney,
dorothy.mckinney@lmco.com

The chapter has had an interesting variety of monthly meeting topics so far in 1999, covering:

1. Systems engineering perspectives on politics
 - "Potomac Fever or Potomac Fog, Or What Is a Systems Engineer Doing on Capitol Hill?" by Frederick Martin in June, summarizing his experience as a Congressional Fellow,
 - "Export Control — Good Politics but Bad National Security Policy?" by Chris Hoerber, Chief Engineer of Space Systems/Loral
2. Career guidance
 - "Improving Systems Engineering Career Prospects In A Better, Faster, Cheaper World" by John Hoschette of Lockheed Martin
3. Requirements management challenges and tools
 - "Requirements Management in the Modern World" by Mark Surles of QSS Inc.
4. Best Practices
 - "Best Practices Guide and Case Study Examples from the French Space Agency" by Jim Brill
5. INCOSE insights
 - "Highlights and Insights from the 1999 INCOSE International Workshop SFBAC" by local attendees to the Workshop.

The chapter has put on an ambitious series of tutorials in January through May of 1999, each of which attracted new members to INCOSE. We even made money on all but two of these tutorials! Topics included:

- "Conceptual Analysis with Models and Objects" by Dr. Dave Oliver
- "Systems & Software Engineering: From Theory to Practice" by Dorothy McKinney,
- "System Requirements Analysis" by Jeff Grady
- "Decision Making and Risk Management — Key to Implementing Systems Engineering" by Barney Morais and Dr. Brian Mar
- "Secrets of High Performance Project Teams — Tools for Building and Maintaining High Technology Teams" by Michele Jackman

More tutorials are planned starting in September — see the chapter website at <http://www.incose.org/sfbac/> for upcoming events.

The chapter is also nurturing several project efforts. The two efforts, which have made great progress, are the application of systems engineering to environmental and public interest domains. Jerry Bauknight <jerry.bauknight@lmco.com>, Ted Dolton, Fred Martin and others are spearheading the first initiative (see article on page 24). The second is the INCOSE ARMOR (Automated Risk Management On-line Resource) development, being led by Tom Jackson <thomas_jackson@cc.littonatd.com> or <tjackson.koakland@worldnet.att.net>. Lastly, efforts are starting to revise the INCOSE Handbook; to contribute to the revised edition, contact the lead editor, Jim Whalen <jtwhalen@earthlink.net>.

INCOSE International Symposium Sydney, Australia July 2-6, 2001

AMBASSADORS WANTED

The Organizing Committee for Sydney 2001 is seeking country, city, enterprise, and professional society ambassadors for Sydney 2001, as follows:

- All countries with present or potential future INCOSE members
- All cities with present or potential future INCOSE members
- All large enterprises with present or potential future INCOSE members
- All professional societies with present or potential future INCOSE members

The job of the Ambassador is to advise the Organizing Committee on marketing aspects of Sydney 2001 to that country/city/enterprise/society, and where possible, to ensure that Symposium promotional information is available to all potential attendees in the Ambassador's area/enterprise of coverage. All Ambassadors will have member status on the symposium's Organizing Committee.

The Organizing Committee is pleased to announce the following ambassador appointments:

- France — Jean-Phillipe Lerat, lerat.xtal@limon.naonet.fr
- Norway — Terje Fossnes, tefossne@online.no
- British Army — David Wright, david.wright@gtnet.gov.uk

NOMINATE TODAY! You can nominate yourself or someone else. Please contact Convenor Robert Halligan at rhalligan@taa.com.au

June 1999 — German Chapter Strengthens International Network!

Herbert Negele, h.negele@lrt.mw.tu-muenchen.de, and Nicole Haertlein, nicole.haertlein@bmw.de

Holding the Annual International Symposium of INCOSE outside the North American continent gave first-time attendees from Europe plenty of opportunities to interact with SE experts from all over the world. We were delighted that the symposium was “right next door” in the U.K.! More than 25 people from Germany took the opportunity to attend the Brighton symposium, contributing nine papers and several panelists to the technical program. Also, our overseas colleagues got the opportunity to visit companies, institutes, and friends in the “Old World” and see many historically significant sites.

Two members of INCOSE did extend their visit to the Old World by continuing their travels on to Germany after the symposium. Bill Schoening of Boeing Company in St. Louis, Missouri, met with representatives of Siemens (from the group’s Medical Systems, Enterprise Switching, Business Services, Plant Automation, Corporate Technology) and Daimler Chrysler (Research and Technology) for an extensive exchange of ideas, and in order to get them acquainted with INCOSE. Since there was an eminent positive feedback to the presentations and discussions, a similar activity is planned for this autumn.

The week after the symposium, the German Chapter of INCOSE was delighted to host an evening presentation by Valerie Gundrum of Lockheed Martin Federal Systems (LFMS), located in Owego, New York. The event was organized by the Technical University of Munich, Institute of Astronautics, which is under the leadership of Prof. Dr. Eduard Igenbergs. Valerie presented on:



Ernst Fricke, Valerie Gundrum, Herbert Negele

1. Experiences in Integrating Development Standards
2. Architecture for a Process Meta-System (awarded a “best presentation” in Brighton).

About thirty people were in attendance, representing three different universities (TU Munich, TU Braunschweig, TU Delft/The Netherlands) and various local companies (BMW, Dornier Satellite Systems, DaimlerChrysler Aerospace, Kayser-Threde, Siemens, QSS). Valerie shared her views on how to implement and improve an integrated systems development process, and how to implement an organizational infrastructure for process deployment and improvement. The excellent presentations were followed with discussions (and wine!) late in the evening at an Italian restaurant.

The close contact between LMFS and the Systems Engineering Group at the Institute of Astronautics (LRT) developed from a case study conducted by Dr. Ernst Fricke and Dr. Herbert Negele last summer. At that time, Valerie Gundrum and Dr. Donna Rhodes (LFMS) agreed without hesitation to receive their INCOSE colleagues from Germany to exchange ideas, experiences, and views on “Best Practices in Process Management.”

For the future, the German Chapter of INCOSE intends to host more events with international systems engineering experts, thus fostering the goals of strengthening and benefiting from INCOSE’s international network. If you happen to be in the Munich area, you are

cordially invited to come and join us for any of our Chapter meetings. Perhaps, where you see that we have no scheduled speaker, you could volunteer, but it’s not required!

July 6, 1999 at 18:00 (Technical University of Munich, Garching, Room 0636) :

- “The CMM-Integration-Project The Common Basis to Model Based Process Improvement,” Fariba Hozhabrafkan, Thomson Training Simulation, U.K.

July 7, 1999 at 17:00 (DSS, Immenstaad):

- A Presentation of INCOSE, Fariba Hozhabrafkan, Thomson Training Simulation, U.K.
- “The CMM-Integration-Project The Common Basis to Model Based Process Improvement,” Fariba Hozhabrafkan, Thomson Training Simulation, U.K.
- German Chapter of INCOSE, Ralf Hartmann, DSS
- “PDM in a Systems Engineering Environment,” T.H. Mandemaker, M.I.S. Organisatie-ingenieurs B.V.

September 14, 1999 at 18:00 (Technical University of Munich, Garching, Room 0636):

- “Configuration Management for Automotive Electric/Electronic Systems,” Pamela Wehlitz, BMW AG

September 29, 1999 at 17:30 (Bosch telecom, Backnang):

- “A Method for the Incremental Software Development and Validation of Complex Distributed Systems,” Dr. Rainer Gerlich, BSSE System and Software Engineering

For more information on these meetings or our chapter, visit our Web page at <http://incose.lrt.mw.tu-muenchen.de>, or contact Nicole Haertlein, nicole.haertlein@bmw.de, voice: +49 89 382 47406.

Washington Metropolitan Area Chapter Having a Banner Year

Jim Pearson, james.a.pearson@aero.org

INCOSE's Washington Metropolitan Area Chapter is experiencing an outstanding first half of 1999. We've had monthly meetings on a variety of topics and with outstanding speakers. Also, there have been two tutorials, on subjects relevant to the local membership and again with excellent speakers. Lastly, plans are rapidly developing for a regional conference in 2000.

The January 12 meeting topic was Collaborative Environments for Today's Multi-company Teams. Eric Honour, one of the founders and guiding lights of INCOSE gave the presentation. Eric summarized the challenges and solutions available for collaborative work environments among companies. An opening segment discussed the changing needs of today's multi-company teams, demonstrating the difficulties and rewards inherent in competitive teaming. Following this context, an exploration of team psychology, drawn from a vast research base, showed the types of intra-team communications necessary for technical development. Eric included the characteristics and urgency of each communications type to help identify the needs for environment tools. Finally, he summarized the classes of tools available today, with examples of each, highlighting the benefits and difficulties of using them across companies.

The February 9 topic was Advancing the State-of-the-Art in Systems. Representatives from the INCOSE Technical Committees were available to our membership, describing the products and how one can tap into the wealth of systems engineering resources that reside within the technical committees. A very popular feature was the *INCOSE Technical Community* handout, which describes each committee, noted what projects were active

within each committee, and provided contact information for key technical committee members.

A Validation and Verification panel discussion was scheduled on April 13. The panel focused on defining V&V, describing what it is trying to accomplish, and identifying issues and stumbling blocks. The panel had the following of panelists:

- Ron Kohl, NASA OMNIBUS Chief Systems Engineer, Intermetrics Inc., talked about software independent validation and verification (IV&V) for mission critical systems and the interrelationships between software, hardware, humans and procedures in large, complex NASA projects.
- Sarah Sheard, Senior Systems Engineer, Software Productivity Consortium, talked about IV&V in Integrated Product Teams.
- Lisa Swan, NSWC, discussed IV&V from the system certification perspective.

May's meeting was an INCOSE Symposium Preview. Three local members, who were to be presenting their papers at the INCOSE International Symposium, were encouraged to strut their stuff before their peers, who, in turn, were encouraged to offer positive comments to better the presentations. We reviewed the following papers:

- Agency-level Systems Engineering for Systems of Systems, by Robert Fenton, FAA.
- An Application of Object Oriented Systems Engineering (OOSE) to an Army Command and Control System: A New Approach to Integration of System and Software Requirements and Design, by Abe Meilich, Lockheed Martin.
- System Issues Related to Implementing on the Internet, by William Mackey, CSC.

The June 15 meeting was held jointly with the Project Management Institute's (PMI) Washington, DC Chapter. Tom Gilb spoke on Evolutionary Project Management, which is applicable to systems engineering,

software engineering and managing strategic planning. It is based on the concepts written about in Gilb's Requirements Driven Management (RDM) book manuscript and tutorials.

Our Chapter Tutorial program started on March 20 with a one-day tutorial on Integration, Validation and Verification led by the WMA Chapter President Jim Armstrong. Jim's presentation noted that IVV activities are often left to the last minute, after the real design work has been completed and the product is being built. The tutorial addressed the need for an early start on IVV activities to reduce program risk. Special emphasis was made of the concept and value of validating requirements with the customer early in the systems engineering life cycle. The tutorial discussed, and was supported by hands-on small team examples, how to plan, organize and execute IVV activities.

The Chapter's second shot at Tom Gilb was a June 18 tutorial on Requirements Driven Management Approach to Systems Engineering. The RDM method is a freely available set of concepts for managing systems engineering. It has four major components:

1. Requirements specification based on a well-defined specification language (called Planguage).
2. The design process (i.e., finding the means to meet the ends) is based on visibly quantified satisfaction of all stated quality and cost requirements, and is monitored by an impact estimation table.
3. Document quality control, based on the software inspection process.
4. Integration of all these processes with a project management process based on the Evolutionary Delivery paradigm, which operates with step deliveries at 2% to 10% of total budget for early delivery and feedback and correction.

For the future, the WMA Chapter is planning the Mid-Atlantic Regional Conference on systems engineering

to be held in the Reston, VA area on April 6-8, 2000 in conjunction with five other chapters in the region: Central Virginia, Chesapeake, Hampton Roads, Liberty, and Southern Maryland. The theme of this conference is Systems Engineering; People, Processes, Technology And Systems. The Call for Papers is provided on page 31 of **INSIGHT**. Additional information is available on the conference web site, www.incose-marc.org.

Southern Maryland Chapter Forms

Peter A. McDevitt, President,
mcdevittpa@navair.navy.mil,
 Mary Redshaw, Secretary,
mredshaw@arinc.com

The formation of a Southern Maryland INCOSE chapter began in February 1998. The core group of organizers recognized the sizable systems engineering infrastructure in place in the Patuxent River community due to the presence of the Naval Air Systems Command, the Naval Air Warfare Center (Aircraft Division), and a growing contingent of support contractors. Beginning in May 1998, a series of planning meetings were held, resulting in communications activities and meetings to stimulate interest in formation of a new INCOSE chapter in the area. INCOSE member applications started flowing from Southern Maryland to the INCOSE Central Office, and soon the fledgling chapter was up to 40 members.

In a series of meetings from July through December 1998 the members developed, modified, and then affirmed the chapter bylaws. A slate of candidates for office was nominated, and elections were held in December. The chapter bylaws were approved at INCOSE Headquarters, and INCOSE Past-President Bill Schoening signed the charter of the Southern Maryland chapter on 21 January 1999. The installation of new officers took place at a luncheon held 23 March 1999. The 1999



Presiding over the officer installation for the South Maryland Chapter is Ken Ptack, INCOSE President (center)

INCOSE president, Ken Ptack, is one of the charter members of the new Southern Maryland chapter. Mr. Ptack read a letter from Mr. Harry Crisp, INCOSE Region V Director, extending congratulations to the new chapter. Mr. Ptack then presided over the installation of new chapter officers and directors.

Chapter members also were honored to have Dr. John Snoderly, INCOSE Technical Co-chair, as guest speaker for the occasion. Dr. Snoderly spoke about the unique role the Southern Maryland chapter of

INCOSE can play in simultaneously influencing the systems engineering perspective pursued by the Navy acquisition community, and representing that community's view in the national/international systems engineering arena. The members of the Southern Maryland chapter look forward to that opportunity and challenge. Contact information for our officers is on the Southern Maryland Chapter summary web page at <http://www.incose.org/chapters/so-md.html>.

San Diego Chapter

Announcement and Call for Papers

INCOSE Region II Mini-Conference

San Diego, California, SAIC Campus Point Facility

Saturday, November 13, 1999

Theme: Systems Engineering Deployment

Systems Engineering as a discipline is applicable to systems and endeavors of all kinds. Why is it so difficult to make it work on programs? This Mini-Conference invites papers from across the broad spectrum of Systems Engineering activities dealing with how Systems Engineering has been successfully implemented. Sample topic areas include the following:

- Enterprise Organizational Structure
- System Architecture Definition and Characterization
- Defining System Requirements
- Structured Re-Engineering of Existing Systems
- Systems Engineering Processes and Practices
- Systems Capability/Maturity Models
- Integration of New Systems With Legacy Systems
- Deployment of Systems, Including Validation and Verification
- Risk Management: Assessment & Mitigation
- Systems Engineering Tools and Techniques
- Systems Engineering Lessons Learned

Paper presentations will be 20 minutes in length, with 10 minutes for questions and answers. Paper selection will be on the basis of a one-page abstract. Abstracts of selected papers will be provided to attendees, but there will not be a Proceedings of full papers furnished to attendees. Speakers are invited to have copies of their papers or their view-graphs available at the meeting for distribution.

Deadline for submission of Abstracts is **September 30, 1999**.

Abstracts may be submitted by E-mail, FAX, or postal delivery to:
 James D. Peterson, 1605 Borana St, San Diego, CA 92111-6939
 E-mail: jdpete@pacbell.net, FAX: (619) 279-2440.

Authors of the papers selected will be notified by **October 15, 1999**.

13TH International Conference on Systems Engineering

Don't delay...Reserve your room at the **Orleans Hotel & Casino** in beautiful Las Vegas Nevada and Register for the 13th International Conference on Systems Engineering. This series of International Conferences is jointly organized on a rotational basis among three institutions, University of Nevada, Las Vegas, U.S.A., Technical University of Wroclaw, Poland, and Coventry University, U.K. In 1999, the 13th International Conference on Systems Engineering is being co-sponsored by the Silver State Chapter of the International Council on Systems Engineering (INCOSE). The conference is being held in Las Vegas, NV, at the Orleans Hotel & Casino, August 9-12, with conference check in starting August 8. See the conference web site at www.icse99@egr.unlv.edu

EXHIBITS

■ **Attention Exhibitors:** There is still time to reserve your booth location. We will hold some special events in the Exhibit Hall to draw the conference participants into the hall. These events include the Conference Icebreaker Reception, Pre-Banquet Social Hour, "Exhibits Only" time, and Symposium lunches. Contact: M. Sam Rindskopf, Phone: (702) 295-3965, Email: m.sam_rindskopf@ymp.gov.

SESSIONS/PAPERS

A partial list of planned sessions follow: Systematic Approaches to Complex Problems

- | | | |
|---|---------------------------------------|--------------------------------------|
| • The SE Process: Insights and Improvements | • Systems Architecture | • Enterprise Engineering Experiences |
| • SE Education (I) | • SE in Department of Energy Programs | • Requirements Management |
| • SE Education (II) | • SE Models and Tools (I) | • System Software Requirements |
| • People and Disciplines in SE | • SE Models and Tools (II) | • SE Integration and Management |
| • SE Standards | • Seeing an Enterprise as a System | • Product Development and Test |

TUTORIALS

■ TOPIC

1. Integrating SE and Project Management
2. Planning and Controlling Collaborative Teams
3. Systems V & V
4. Decision Making and Risk Management
5. Systems Engineering

■ PRESENTED BY

Douglas McAulay
Eric Honour
Jeffrey O. Grady
Brian Mar and Barney Morais
Dr. William W. Wells, Dr. Ovadia Lev, James Fay

TOURS

A tour has been planned to Yucca Mountain the site currently being studied as the nations potential High-Level Nuclear Waste disposal site. The only cost of the tour is for your lunch, which is estimated to be \$9.00, the Department of Energy provides free bus transportation. This tour is limited to the first sixty people that request the tour with their paid conference registration. Spouses of ICSE attendees are welcome; however, children under the age of 16 are not allowed. The tour will be on Friday, August 13, 1999, and will leave Las Vegas from the Orleans Hotel & Casino about 6:00 AM and return about 5:00 PM (photo identification is required).

A tour of the Hoover Dam will also be provided. Details and cost will be provided at the conference.

SPONSOR ORGANIZATIONS

TRW

Duke Engineering Services
Science Applications International Corporation (SAIC)

Call for Papers

Call for Papers

Systems Engineering: People, Processes, Technology, and Systems

International Council On Systems Engineering (INCOSE) Mid-Atlantic Regional Conference

April 6-8, 2000 • Sheraton Hotel – Reston, Virginia

Sponsored by the Washington Metropolitan Area, Central Virginia, Chesapeake, Hampton Roads, Liberty, and Southern Maryland Chapters of INCOSE

Original papers are requested on topics related to the SE: People, Processes, Technology, and Systems theme. Submittals from industry, government, and academia are solicited. Submittals from students are encouraged as we are planning for student paper sessions. Some candidate program topics include:

- Systems Engineering Processes
- Information Technology
- Person and System Interfaces
- Applying SE in Customer Services
- Making Processes People Friendly
- Using SE in Web Site Design
- Use of Internet Technology
- Systems Engineering Training, Mentoring, or Education
- Business Process Engineering/Reengineering
- System or Process Integration Issues and Challenges
- Use of Tools, Modeling, or Simulation to Facilitate Integration
- Practical and Theoretical Approaches for Managing Integration
- Using SE in the Management of Data and Information
- Case Studies and Lessons Learned

■ **Submission Requirements For Paper Summaries:**

Submit a 2-4-page paper summary. Include: 1) title, author(s) and affiliation(s), and brief biographical sketch; 2) a brief abstract (~50 words); 3) a concise description of the approaches or methods used – emphasizing elements that are important, unique or innovative; 4) a summary of the main points, conclusions drawn, and/or lessons learned; and 5) contact information for the primary author – including name, affiliation, address, email, and phone number.

It is our intent to work and communicate primarily via email. Submittal as an MS Word document is strongly preferred. Address paper-related questions to the Technical Program Chair.

■ **Send Paper Summaries to:** Pohlmann-wma@erols.com

■ **Schedule:**

- | | | | |
|------------------------------|----------------|--|----------------|
| • Call for Papers Issued | May 20, 1999 | Final Papers Due | Jan. 31, 2000 |
| • Paper Summaries Due | Sept. 15, 1999 | Presentation Materials Due
– Hardcopy Plus Electronic | |
| • Notification of Acceptance | Dec. 1, 1999 | | March 15, 2000 |

Technical Program

Dr. Lawrence D. Pohlmann
Strategics Consulting
(703) 406 2595
Pohlmann-wma@erols.com

Chair Conference Chairs

Ms. Dona Lee
Dynamic Systems
(703) 684-4060
Donalee@dynamics.com

Mr. David Long
Vitech Corporation
(703) 883-2270
Dlong@vtcorp.com

Additional Information on the Conference Web Site: www.incose-marc.org

INCOSE represents an incredible international asset, and as systems engineering becomes more and more important, we'd like you to increase its profile by nominating outstanding systems engineers as INCOSE fellows. The award of INCOSE Fellow was created in 1998, seven INCOSE members were honored, and three more were elected in early 1999. If you know someone who has advanced the discipline of systems engineering, please consider nominating him or her.

• What are we looking for in an INCOSE Fellow?

INCOSE is looking for individuals with a significant history of Systems Engineering achievement in industry, government or academia. Of course, the key factor should be the quality of the nominee's work in systems engineering. As an academic, this could be someone who has pushed the theory, written great teaching material or simply acted as a marvelous teacher for a string of successful systems engineers. An industrial fellow would be expected to have made a real difference and a contribution to systems engineering practice — for example, by intellectually leading the development of a string of ground-breaking products. Those in government would be expected to have contributed significantly to acquisition-related efforts. These products should represent systems engineering at its best. If the nominee crosses the boundaries between industry and academia, this is even better. We want people who have looked outwards to raise the profile of systems engineering, and international experience is a definite plus.

Becoming an INCOSE Fellow will never be a routine achievement. Membership will be restricted to about 1% of the INCOSE membership, and is expected to eventually build up to about 30 people (for the current size of INCOSE). Fellowship

Call for Nomination of INCOSE Fellows

will therefore be restricted to those with real achievements.

• Nominating INCOSE Fellows

The INCOSE Fellows Select Committee will be pleased to accept nominations for new INCOSE fellows. Nominations may be made by INCOSE members or by INCOSE fellows. Nomination packages will be accepted until December 1, 1999. Final discussions by the INCOSE Fellows Select Committee will be held at the INCOSE International Workshop in January 2000. This committee will submit a list of recommended fellows to the INCOSE Board of Directors for their April meeting. New fellows will be announced at the International Symposium in Minneapolis, Minnesota U.S., July 16-20, 2000.

What about the administrative details? The person you nominate should have been in INCOSE for five years. Additionally, the nominator must be an INCOSE member, and should use an existing Fellow to support the nomination. We will make exceptions for exceptional candidates who have done systems work in another domain.

A Letter of Support follows this article, or is available on the INCOSE Web site at <http://www.incose.org>. The full details of the nomination policy are available on the INCOSE Web site.

If you know someone who has contributed to systems engineering, please complete the form on page 34. If you have any questions, drop an e-mail to Terry Bahill <terry@SIE.Arizona.edu>, the

Chairman of INCOSE Fellows Committee.

• Who are the current INCOSE Fellows?

Three new Fellows were elected at the first meeting of the INCOSE Fellows, which took place in the International Meeting in Phoenix in January 1999. Their names were announced at the banquet at the 1999 symposium in Brighton, U.K.

Terry Bahill, Professor of Systems Engineering at the University of Arizona, is Chair of the INCOSE Fellows. His research interests are systems engineering theory and practice, modeling physiological systems, eye-hand-head coordination, validation of knowledge-based systems, and system design. He is the Editor of the CRC Press Series on Systems Engineering, and also a Fellow of IEEE.

Systems engineering can also apply to important human activities, and Terry has applied his scientific findings to produce the Bat Chooser, a patented system that computes the Ideal Bat Weight for individual baseball and softball batters.

Benjamin S. Blanchard is a Professor of Engineering-Emeritus at Virginia Polytechnic Institute and State University. He is also a consultant in systems engineering, reliability and maintainability, maintenance and logistics support, and life cycle costing. Prior to his current role, he served as Assistant Dean of Engineering for Public Service, College of Engineering (until June 1995), and as Chairman of the Systems Engineering Graduate Program (1979-1996). He taught courses in

systems engineering, reliability and maintainability, and logistics engineering. Before joining Virginia Tech in 1970, he was employed in industry for 17 years where he served in the capacity of design engineer, field service engineer, staff engineer, and engineering manager (Boeing Airplane Co., Sanders Associates, Bendix Corp., and General Dynamics Corp.). Prior to his industry career, he was an electronics maintenance officer in the U.S. Air Force for several years.

Professor Blanchard has written no less than eight systems engineering books. Professor Blanchard is a Charter member, Fellow, CPL, newsletter editor, member of the Board of Advisors, and past-president of the International Society of Logistics (SOLE); a Fellow of several other professional organizations (IIE, IEEE, NDIA, and CLM); and "Visiting Professor" at the University of Exeter (UK).

George Friedman, Professor of Engineering at the University of Southern California, received his Ph.D. from UCLA in 1967. His primary research interests include the unification of systems engineering processes and the management of complexity, especially as it involves cognitive science. Also, he is a research director of the Space Studies Institute in Princeton. George is a Fellow of IEEE and IAE, and associate fellow of AIAA. He served as Past president of INCOSE, vice president of publications from IEEE (AESS), and executive vice president of SSI. He retired as corporate vice president of engineering and technology of Northrop in 1993.

James N. Martin is a systems engineer and program manager at Raytheon Systems Company in Plano, Texas. He worked at AT&T Bell Labs from 1983 to 1996 on wireless communications systems and underwater fiber optic systems. He now works for Raytheon on satellite and airborne wireless broadband communication systems. At both AT&T and Raytheon he has been involved in process improvement activities for systems engineering. He developed a standardized process for systems engineering that was selected as the "best current practice" for use throughout AT&T. This material was later expanded into a full textbook called

Systems Engineering Guidebook, published by CRC Press in 1996. He also developed standardized methods and tools at AT&T for requirements management, configuration management, test management, and technical reviews.

He was selected to lead the effort in developing a U.S. national standard on systems engineering, now published as ANSI/EIA 632. He has presented tutorials and seminars on this standard throughout the United States and at the 1999 symposium in Brighton, U.K. Within INCOSE he has served on the board of directors, founded the requirements management working group, and now serves as the chairman of the Standards Technical Committee.

Andrew P. Sage received his BSEE degree from the Citadel, SMEE degree from MIT, and Ph.D. from Purdue, the latter in 1960. He received honorary Doctor of Engineering degrees from the University of Waterloo in 1987 and from Dalhousie University in 1997. He has been a faculty member at several universities and, in 1984, he became First American Bank Professor of Information Technology and Engineering at George Mason University, and the first Dean of the School of Information Technology and Engineering. In May 1996, he was elected as Founding Dean Emeritus of the School and also was appointed a University Professor. He is an elected Fellow of the Institute of Electrical and Electronics Engineers, the American Association for the Advancement of Science, and the International Council on Systems Engineering. He is editor of the John Wiley textbook series on Systems Engineering, and the INCOSE Wiley journal Systems Engineering. In 1994 he received the Donald G. Fink Prize from the IEEE and a Superior Public Service Award, for his service on the CNA Corporation Board of Trustees from the U.S. Secretary of the Navy, respectively. His interests include systems engineering and management efforts in a variety of application areas including systems integration and reengineering.

Richard Stevens is CTO of QSS, the company that supplies the DOORS requirements management tool. Richard gained much of his systems engineering

experience at the European Space Agency (ESA), working on software and systems engineering. This theory was turned into prototype systems engineering tools at ESA, and the industrial interest in these provoked Richard into co-founding QSS. Richard has never believed that tools are enough, and so has written and taught much of the company's methods training. He claims, "Giving courses and workshops to industrial engineers is the best way of learning what works and what doesn't." He is the author of several books, most recently of *Systems Engineering – Coping with Complexity*, adopted by several universities for their coursework. He is currently interested in the industrial reality of systems engineering and theory of how to control risks during the start-up of projects.

Wayne Wymore earned BS and MS degrees at Iowa State University, and the Ph.D. at the University of Wisconsin, Madison, all in mathematics. He is Professor of Systems and Industrial Engineering (SIE), Emeritus, at the University of Arizona where he was founder and first Chairman of the SIE Department and first Director of the Computing Center. He is charter member #25 in INCOSE, elected to the first Board of Directors and subsequently re-elected, founder and first President of the Southern Arizona Chapter of INCOSE and among the first seven Fellows designated by INCOSE. While managing the SIE Department, teaching and developing courses, researching into the system theoretic foundations of systems engineering, and consulting (50 organizations in 13 countries in 21 fields of application), he authored: *A Mathematical Theory of Systems Engineering: The Elements*, 1967, *Systems Engineering Methodology for Interdisciplinary Teams*, 1976, and *Model-Based Systems Engineering*, 1993, at an average rate of 11 years per book. *System Functional Analysis and System Design, Phase 2 of Model-Based systems engineering* is forthcoming "soon" from CRC press.

HANDWRITTEN COPY IS NOT PERMITTED
INCOSE 1999 LETTER OF SUPPORT FORM

NAME OF CANDIDATE _____
 LAST, First, Middle

NAME OF SUPPORTER _____
 LAST, First, Middle

NAME OF NOMINATOR _____
 LAST, First, Middle

A. If you are not qualified to judge the work of the candidate, please check this box ☐ and notify the nominator immediately.

B. How long have you known the candidate and in what capacity? _____

C. On the basis of the work of the candidate, which you are competent to judge, please indicate whether or not, in your own judgment, the candidate meets the requirements for Fellow grade. What distinguishes this contribution from the norm?

D. **CHECK AT LEAST ONE BOX**, identifying the area of the most significant contribution which qualifies the candidate for Fellow grade:

☐ Practitioner ☐ Researcher ☐ Teacher

E. INDICATE BY AN "X" below where the individual contributions of the nominee fall in the qualifications for Fellow grade.

Not Yet Qualified	Marginally Qualified	Qualified	Highly Qualified	Extraordinarily Qualified
0	3	5	7	10
----- ----- ----- -----				

F. _____
 Date Your Signature INCOSE Membership Number

Business Affiliation _____

Street Address E-mail Address

City /State /Province Zip /Postal Code Country Tel. No. (Incl. area code) Fax No. (Incl. area code)

G. Are you a Fellow of INCOSE or any other professional society? If so, which society? _____

H. Please include a brief resume of your career.

I. Please return this form to:
 Terry Bahill
 Department of Systems and Industrial Engineering
 The University of Arizona
 1127 East North Campus Drive
 Tucson, AZ 85721-0020

Notes from the Technical Board Chair

Dr. John Snoderly,
snoderly_john@dsmc.dsm.mil

The 1999 symposium in Brighton was a huge success from the Tech Board perspective. The support provided by the hosts of the symposium was superb, as was everything else that occurred there. The Technical Committees and Working Groups added new members and, hopefully, new enthusiasm to their products and services. An example is the Compliance Assessment Working Group (CAWG), which was, as Sarah Sheard said, "on life-support," came to Brighton and sprang to life with a great deal of enthusiasm, interest, and new members.

At the closing plenary, I presented several challenges that I foresee for INCOSE:

1. **Chapter involvement in INCOSE Working Groups.** This subject was discussed in a joint meeting of the chapters and Board of Directors. I believe that this is one of the keys to generating new interest within local chapters. The synergism of a chapter can be of great value in the generation of INCOSE products for its members (e.g., SE Handbook from San Francisco Bay Chapter). The chapters, in turn, would provide a large reservoir of talent for the working groups.
2. **Use of Collaborative Tools.** The Standards TC has signed up to use Mesa Vista® tool for Web based collaboration (see Mesa Vista announcement in page 38). This tool will provide better communication between members of the committees. I am hopeful that we will see more use of this in the coming months as other groups within INCOSE use Vista.
3. **More International Participation on Working Groups.** Interest shown at Brighton was exciting as a means of broadening the "international" aspects of working group membership. The

addition of 170 new members at Brighton provides a larger international SE technical base. This is important to the world wide technical recognition of INCOSE SE competence.

4. **Paper Review Process.** Richard Harwell developed this new process which established new paper scoring criteria, with expanded emphasis on technical content and value to symposium. This new process also established criteria and a process for the selection of reviewers. In concert with this, the Tech Board Chair and Co-Chairs have an action item to establish a standardized set of instructions for both reviewers and review coordinators for future symposia. The TB also established a mechanism for identifying and selecting a student paper for the "Brian Mar Award."
5. **The potential use of an INCOSE Review Board to provide systems engineering analysis of incidents and accidents throughout the world.** This may require a separate recognized review team made up of systems engineering experts. There is much work to do before this can be accomplished.

These are a few of the areas that were discussed during the meetings conducted at the symposium. Many of the technical papers, panels and discussions were excellent this year. The abstracts are on the INCOSE Web site (www.incose.org). The proceedings, available in hardcopy and CDROM formats, can be ordered from the INCOSE Central Office (see page 3 for contact information). There are limited copies, and I encourage you to obtain a copy for your technical library.



In Memorial

NORSEC, the Norwegian chapter of INCOSE, lost their founding father (member number 47) and current past-president when Professor Odd Andreas Asbjørnsen passed away on 26 May 1999. He was a tireless advocate for the use of systems engineering in Norway, both in industry and education.

Andy, as he called himself during his tenures at the Universities of Houston and Maryland, was full of enthusiasm and the joy of living, and this trait flowed into everything he did. His colleagues at the Technical University of Trondheim (NTNU) respected him and admired his forward-thinking attitudes. His students found his lectures stimulating, challenging and interesting.

Those of us in NORSEC have lost a mentor, a colleague and a friend and share our loss with his family and the international community of his friends.

Respectfully submitted,
Cecilia Haskins

The Power of One: How YOU Can Help INCOSE Grow

Membership Committee Co-Chairs: Dona Lee, donalee@dynsys.com, and Lew Lee, lew.lee@trw.com

Suppose you stopped what you were doing right now and took the time to tell just ten people all about INCOSE and why you decided to become a member. Now what if you invited each of those ten people to a local chapter activity. It might be a monthly meeting, a tutorial, or a regional conference. If those ten people each attended and found the networking to be as valuable as you do, they might join. Now what if those ten people each told ten people all about INCOSE. And so on and so on...If this happens just six times, by doing just this a little, you will have reached one million prospective members. It's amazing, isn't it, how one person can produce a powerful, positive impact on an organization?

INCOSE's chapters, both small and large, play an important role in introducing potential new members to the organization. Let's focus on INCOSE's 34 chapters and what they're doing to provide the energy and focus for building membership through grassroots activism. The Seattle Metropolitan chapter, in Region I, has long been successful holding monthly meetings and tutorials for systems engineers in the region. But that's not enough; the Seattle chapter has developed Partners In Industry (PII) program as a mechanism to promote the practice and understanding of systems engineering in the greater Seattle area. In conjunction with the Vancouver chapter, they're also working to gain regional strength for systems engineering by creating a Pacific Northwest Regional INCOSE body.

In Region II, the Colorado Front Range Chapter is putting together an exciting program for a regional conference in March 2000 focused on Systems Approach to Product Innovation and Development in

Hyper-Competitive Environments. Another chapter located in Region II, the San Francisco Bay Chapter sets the standard for offering tutorials for the local engineering community. Following great success with ten tutorials during the past four years, their 1999 tutorial series includes these six offerings: *Conceptual Analysis with Models and Objects*; *Systems & Software Engineering: From Theory to Practice*; *System Requirements Analysis*; *Decision Making and Risk Management—Key to Implementing Systems Engineering*; *Secrets of High Performance Project Teams—Tools for Building and Maintaining High Technology Teams*; *Systems Architecting*; and *Engineering of Complex Systems*. In August, the Silver State Chapter in Las Vegas, Nevada is co-sponsoring the 13th International Conference on Systems Engineering.

In Region III, all of us know of the United Kingdom chapter and all they did to make this year's INCOSE international symposium a success. But what about the German and NORSEC chapters — they've translated INCOSE materials into German and Norwegian, respectively, helping INCOSE to reach out internationally. Chapters also help INCOSE broaden the application of systems engineering as evidenced by an October program by the Liberty chapter in Region IV on Education Reform for Kindergarten through 12th Grade.

Region V is a hotbed of activity, gaining several new chapters chartered over the last 18 months. This region exhibits the tremendous amount of energy and interests that leads to strong chapters and a loyal following. The Hampton Roads Area chapter sponsored a free symposium on Capability Maturity Models in July, to be followed by a symposium on Earned Value Management later

in the year. The long-standing Washington Metropolitan Area chapter is bringing together six chapters across Region IV and V to organize a Mid-Atlantic Regional Conference for April 2000. Their focus is Systems Engineering: People, Processes, Technology, and Systems. In Region VI, INCOSE's affiliate, the Systems Engineering Society of Australia, is busily preparing their Systems Engineering, Test, and Evaluation Conference.

People discover INCOSE in a variety of ways—by searching for systems engineering information on the World Wide Web and visiting the INCOSE and chapter home pages, through word of mouth, through their company, by attending a local meeting, and through publicity in local publications. Don't assume that e-mail announcements, posted flyers in workplaces, and announcements at staff meetings are sufficient invitations to learn about or attend INCOSE events. Let's not take for granted the critically important role that each of you and your local chapter have in expanding the influence of INCOSE, increasing membership, and creating visibility for INCOSE in your region and internationally.

INCOSE Online

Dynamic Discussion List!

Valerie Gundrum, Chair Communications Committee, valerie.gundrum@lmco.com

One benefit of INCOSE membership is being able to subscribe to and participate in our online discussion list. The purpose of this article is to describe our reflector software, the mechanics of implementing the list, the “rules of engagement,” and how you can subscribe.

INCOSE's list serve capability is enabled using a software application called *IMail*. This application is loaded on INCOSE's server, which is based in Dallas, Texas. Members of INCOSE's Communications Committee and Central Office perform general administrative tasks for the e-mail lists in IMail. Nearly all of INCOSE's committees and boards, and a few of its working groups and chapters, use this tool for general broadcasts within their group. In general, only members of each group can send and receive messages to their group's distribution list.

There is two cross-organization email distribution lists. One of them is the Admin List. This list is used to send announcements to every current INCOSE member who provided an e-mail address on their membership application. This list is moderated, and its use is strictly for INCOSE-specific announcements.

The other cross-organization reflector, which is open to general member use, is the Discussion List. People who describe to the Discussion List have the benefit of active and engaging interactions with INCOSE members worldwide.

The discussion list has garnished a love-hate image within INCOSE. Why you ask? Currently, there are about 450 people subscribed, about 15% of our current membership. Of this number, approximately 40

people actively participate. These participants are very dynamic, and enjoy the repartee with each other. The rest of us sit back and enjoy the action! As chair of the INCOSE Communications Committee, I am occasionally called on to intervene on the behalf of someone who feels insulted, or to clarify the “rules of engagement.” But, this is rare, and the list is self-regulating. From a personal passive observer standpoint, I find that the knowledge gleaned from the comments of my well-read, educated, and experienced peers is worth the price of admission. What is this price? Sometimes, for a controversial or hot topic, we get a lot of Discussion List e-mail in one day.

Participation on the discussion list is optional, and by subscription. Directions for subscribing and unsubscribing to the Discussion List are found on the INCOSE Web site, at www.incose.org. Please remember that we need to verify the currency of your membership prior to placing you on the distribution list. Should your email change, or if you are experiencing any difficulties, please send a note to webmaster@incose.org.

A few courtesies are common for discussion lists, and ours has some also. You are requested to:

- Exhibit basic conversational courtesies when posting and responding to people's queries.
- Remember that Discussion list members are multi-national, and, even though we all are using English, there are many ways to mis-connote phrases and terms.
- Assume good faith on the part of all senders. Cynicism and disbelief are common and expected attributes in an engineer's personality!

- If the thread of the discussion has changed, please update the subject line.
- You may desire to take one-on-one conversations “off line.”
- Cite your references, e.g., author, title, publication, date.

A Contribution from the INCOSE Discussion Reflector

The following paragraphs were an INCOSE Discuss List thread that received “two thumbs up” from INCOSE member, Jack Ring. In his opinion, Paul Gartz presents a superb, systems engineering case study on what can be achieved when practices are allowed to work, and when you protect the practitioners from all intervening and contravening influences until the practitioners are ready to consider the effects of each additional influence. The influences can show the deleterious effect, if any, on system effectiveness due to each subsequent influence.

Jack Ring asserts that this “skunkworks” mode is typically not allowed, especially in larger companies. The net of being able to pursue true systems engineering is that situations, which may seem to be impossibly complex, can be successfully resolved if the practitioners are not only adept at “separating concerns,” but are allowed to do just that.

Paul Gartz comments were posted on May 17, 1999 in response to comments from William McCumber. McCumber stated, “I tried prescience once by advocating an “all-up, pull back” design approach. The technique was to design the system as if you had no financial limitations, and that all the various customers' needs were to be satisfied. At the system level, the individual features were just blocks on the system internal block diagram. Each hardware and software block was just stubbed in to the

main body of the system. Getting to the current objective function was then a matter of assigning characteristics to the stubs.”

Gartz’s response: I found your comment about a process of “all up...pull back” interesting, and it brought back memories about one of the best SE management experiences that I have had in quickly reaching an objective function. In the early 1970s, I worked for Bell Labs at the time when we were tasked to develop an effective anti-ballistic missile system at the height of the cold war...called SAFEGUARD. Our country was in the middle of SALT II. To support some of Henry Kissinger’s negotiations, our team was asked to do preliminary systems design of an option to defend the National Command Authority (NCA) against an all-out nuclear attack. Our executive management team told my technical team to go “full out” in the design as if there were no constraints of time or money. We quickly zeroed in on a solution. They then added the constraints, and we creatively adjusted the design for each constraint to still get as close to the ideal design, which we now knew, as possible. This was very successful AND fast!

One of the key lessons for me was the PROCESS by which a team tackles a large, multivariate problem (read: objective function). If I look at the issues that we practically and normally face on many projects, they involve the politics of minutia on various traditional solutions to a problem, and not looking out of the box for a good design space of alternatives from which to choose. The “people issues” dominate the process. I have found the above technique helpful in blasting past these phenomena. Furthermore, for most real world problems, finding an optimization to an objective function (as stated by the customer directly, or inferred through discussion or other method) using mathematical means, such as any of the linear/non-linear programming techniques, is not very likely. As

Gerry Weinberg pointed out years ago, systems consist of large, medium and small number types. Probability is a tool for the former, closed-form math for the latter, and systems engineering for all the interesting medium number systems (airplanes, cars, biomedical devices, software, etc.). By this, Gerry meant that the solutions to Medium number systems had to be gotten by people working together.

So, the real underlying issue is that if you can’t easily discern the Objective Function from the customer and stabilize it, and if the design process cannot be plugged into a machine that generates the answer, then we are stuck at both ends with the messy reality that we need humans with all their limitations to be the prime consideration in the SE process itself. DeMarco concluded this in part years ago with Peopleware. A big, old traditional aerospace company, Boeing, is reorganizing to give greater and greater emphasis to the people part of the process. And there are many more examples.

Within INCOSE I don’t much see this point of view emphasized. We keep discussing and promoting processes and standards that “should be accepted” if only the management were smart enough to realize it, and so on. While some of this dialog is true — in that there is a long learning curve to understand, accept, and support SE — if we had a better box of tools to present to management that they (as people), that customers (as people) and designers (as people) could quickly relate to, the chances are that we could sell SE a lot faster.

Paul Gartz is an employee of The Boeing Company. William McCumber and Jack Ring are self-employed consultants. All three are frequent, enlightening, and entertaining contributors to the INCOSE discussion list. For more information on subscribing to the discussion list, visit the INCOSE Web page at www.incose.org.

INCOSE Receives Mesa/Vista for use by Working Groups, Committees, and Boards

Press Release contributed by Mesa Systems Guild, and edited Valerie Gundrum, Chair Communications Committee, valerie.gundrum@lmco.com

Warwick, RI — June 28, 1999.

Mesa Systems Guild, Inc., a premier provider of web-based product development and project management solutions, announced it will provide the Mesa/Vista collaborative environment to the International Council on Systems Engineering (INCOSE). The use of this tool will facilitate communication within working groups, boards, and committees. Mesa/Vista is used by many organizations as a “Project Portal” for managers and development teams that need access to all project-related data.

“INCOSE is delighted that Mesa Systems Guild is providing Mesa/Vista to our organization,” said Ken Ptack, INCOSE president. “With the wide geographic distribution of our members, we believe Mesa/Vista will greatly enhance the ability of our committees, working groups, and boards to develop products, communicate, and conduct good engineering and management practices.”

Mesa/Vista provides a way to collaborate, manage, and integrate project data within an existing environment. This information can be accessed using a web browser on any platform, from any location. This enables INCOSE users to make better, faster decisions based on the most recent information and increases the productivity by providing immediate access to information needed to complete tasks.

“Mesa knows that systems engineers are crucial to developing competitive products in today’s global markets,” said Alan Hecht, vice president of Mesa. “We are thrilled to provide the Mesa/Vista environment to enable INCOSE working groups and committees worldwide to collaborate and share

their systems engineering knowledge.”

INCOSE members will receive more details about how Mesa/Vista is being used within the organization in upcoming issues of **INSIGHT**.

■ More About Mesa's Products.

Mesa's innovative Mesa/Vista product line provides a project portal for managers and development teams who need access to all data related to their project.

Mesa/Vista allows these managers to collaborate, manage, and integrate project data within an existing environment. Mesa/Vista supports multiple project teams, but is also available for smaller or singular teams through Mesa/VistaPM Pro and Mesa/VistaPM.

The Mesa/Vista product line also includes the Mesa/Vista Risk Manager and Mesa/VistaDB applications. Mesa/Vista Risk Manager allows project team members to identify, analyze, measure, prioritize, monitor, and mitigate the uncertainties encountered in a development process. Mesa/VistaDB web-enables any relational database through a consistent user interface for access to project related information.

Mesa/Vista plug-ins exist for Rational Rose, Sterling's COOL:Teamwork, Artemis' Views, Microsoft Project*, Primavera Project Planner and Scitor's Project Scheduler 7.

About Mesa Systems Guild, Inc.

Mesa Systems Guild, Inc., is a

privately held corporation whose mission is to develop, market and maintain collaborative web-based product development solutions. Mesa provides project management solutions for a wide range of corporations including Abbott Laboratories, Boeing Aircraft, Ericsson Communications, Lucent Technologies, NASA, and Westinghouse. For more information about Mesa, visit the Web site at <http://www.mesavista.com>.

If your working group, chapter, or committee is interested in using Mesa/Vista, contact Bob Scheurer, Vista administrator and INCOSE Communications Committee member, at bscheure@ralston.com.

Press Release used with permission from Mesa Systems Guild. For the full press release, visit the Mesa Systems Guild Web site.

People on the Move



Colonel James E. Armstrong Jr., currently Professor and Chair of the Department of Systems Engineering at the United States Military Academy, will become a Visiting Professor in the Department of Computer Science at the United States Air Force Academy in Colorado Springs, Colorado. Jim recently completed co-authoring a book with Andy Sage, *Introduction to Systems Engineering: Methods and Technologies for Engineering Trustworthy Systems*, that is available from John Wiley. Jim also contributed a chapter on "Issue Formulation" to the recently published Wiley Handbook on Systems Engineering and Management. Jim is looking forward to joining the Rocky Mountain INCOSE Chapter this summer. His new email is jim.armstrong@usafa.af.mil.

Peter Brook has recently been elected to the Royal Academy of

Engineering. The citation includes the work Peter has done in recent years to promote the practice of systems engineering in the United Kingdom. In this position, his goals are to continue promoting the best interest of systems engineering and INCOSE. Peter can be reached at pbrook@dera.gov.uk.

Tyson Browning has completed his Ph.D. in Technology, Management, and Policy (technology management and systems engineering) at the Massachusetts Institute of Technology. He now works for Lockheed Martin Tactical Aircraft Systems (Fort Worth, Texas) on advanced process integration. Tyson can be reached at tyson.browning@lmco.com or tyson@alum.mit.edu, or (817) 777-2043.

Dr. Donald P. Clausing received the Professional Achievement

Citation in Engineering by the Iowa State College of Engineering in March 1999. Don is an alumnus of Iowa State, receiving his BS in Mechanical Engineering in 1952. He is presently the Xerox Fellow in Competitive Product Development at the Massachusetts Institute of Technology in Waltham, Massachusetts, USA. Currently, Don is on the INCOSE Board of Directors as a Region IV representative. Don can be reached at clausing@MIT.edu.

Lawrence D. Pohlmann has retired from The Boeing Company and has established Strategics Consulting. Larry, a founding member of INCOSE, has been active at chapter and national levels of INCOSE in a number of capacities. Currently, he chairs the Systems Engineering and The Internet Interest Group, and is the Technical Program Chair for the upcoming INCOSE Mid-Atlantic Regional Conference (see www.incose-marc.org). You can contact Larry at Pohlmannld@erols.com or (703) 406-2595.

Industry News

Cornell University Introduces Systems Engineering Master of Engineering Option

Jennifer Shea, jhs2@cornell.edu

As engineering systems become more and more complex, there is an increasing need for engineers with systems engineering expertise as well as expertise in a particular engineering discipline. They need to be able to employ diverse interdisciplinary skills, determine systems requirements, integrate system components, ensure total system operability, and understand the various economic forces in the marketplace. In order to fulfill this need, the Cornell University's Master of Engineering (M.Eng.) degree program has added an Option in Systems Engineering. In 1998-99, the program's first year, more than twenty M.Eng. students chose this option. The program is being expanded for 1999-2000.

The Systems Engineering M.Eng. Option was conceived and organized by a group of Cornell Engineering faculty with strong encouragement and advice from external industrial supporters. The Option is coordinated and overseen by a committee of faculty from five different departments in the Engineering College: Civil and Environmental Engineering, Computer Science, Electrical Engineering, Operations Research and Industrial Engineering, and Mechanical and Aerospace Engineering. The committee works cooperatively with the participating fields and the Master of Engineering program, and maintains continued close contact with industry. Representatives from eight companies — Xerox, Corning, Lockheed Martin Federal Systems in Owego, Lucent Technologies, General Electric, Delphi Electronics, Applied Materials, General Motors — attended the College of Engineering's first Systems Engineering Day, on May 13, 1999, to offer their

feedback on and ideas for the program. The industry representatives include INCOSE members Donna Rhodes and Valerie Gundrum from Lockheed Martin, Owego, New York and Tim Kelliher from General Electric, Schenectady, NY.

Cornell's Systems Engineering Option treats the concepts of systems engineering, their applications and their underlying fundamentals in an integrated way by requiring both core courses and a cross-disciplinary design project. Students acquire the technical competence in their chosen fields, as expected of every Cornell Master of Engineering candidate, while they also are introduced to the fundamentals and applications of systems engineering not usually encountered in technical degree programs.

Students participating in the Systems Engineering Option enroll in one of the participating M. Eng. Fields:

- Aerospace Engineering
- Agriculture and Biological Engineering
- Applied Engineering Physics
- Civil and Environmental Engineering
- Electrical Engineering
- Mechanical Engineering
- Operations Research and Industrial Engineering

Their undergraduate preparation may be in any engineering discipline. The program is designed to accommodate both recent graduates and those who already have industrial experience.

The Program of Study.

Each student's program is arranged by the M. Eng. field in which he or she is enrolled, and fulfills the course requirements set by the field.

In addition, each student takes the following courses which presently constitute the Systems Engineering Option requirements:

- Systems Engineering Project, (Fall, 4 credits; Spring, 4 credits)
- Applied Systems Engineering (Fall, 3 credits)
- Engineering Project Management (Fall or Spring, 4 credits)
- At least one other systems-oriented course

The two-semester Systems Engineering Project is central to the Systems Engineering concentration. The largest project, RoboCup, entails constructing a team of fully autonomous robots to enter in the Robot World Cup Soccer Games. This project provides an excellent platform for exploring many of the key aspects of Systems Engineering, including system design, systems and technology integration, systems analysis, and system engineering management. To maximize the team's expertise and knowledge base, the project includes a balanced mix of students from the various engineering disciplines. (For more information on the RoboCup tournament, see www.robocup.v.kinotrope.co.jp/02.html.)

Students whose primary interest is in systems that are not electromechanical can choose another systems engineering project. In 1998-99, they included Product Development, Global Positioning Systems, Wireless Communications, and Hybrid Electric Vehicle Development.

The program is being actively developed. Existing courses are being revised and new ones developed. Students with adequate preparation should be able to complete a M. Eng. program with a Systems Engineering Option in two semesters plus the January intercession period, which is used for part of the group project work. More information may be obtained from the Systems Engineering web site: <http://www.engr.cornell.edu>

Report on Participation by INCOSE in the ISO/IEC JTC1/SC7 Meeting in Curitiba, Brazil, 23-28 May 1999

Robert J. Halligan, INCOSE ISO Liaison Representative, RHalligan@taa.com.au

ISO and IEC

The International Organization for Standardization (ISO) is the largest of the many international groups that promote international industrial and technical co-operation. ISO attempts to bring together the interests of standards producers and standards users in the preparation of international standards. ISO is a non-government organization whose members are the official standards bodies of 96 countries.

The work of ISO covers virtually every area of technology, with the exception of electrotechnology, which is the responsibility of the International Electrotechnical Commission (IEC).

Committees, Subcommittees and Working Groups

The work of ISO is carried out by Subcommittees and by Working Groups (WGs) which report to the Subcommittees. The delegates are nominated by member bodies (National Bodies) and by Liaison Organizations such as INCOSE. (INCOSE has sought Liaison status with ISO.) The working groups of SC7 are shown in the table below:

WG1	Open Distributed Processing (ODP) – Frameworks and Components
WG2	System Software Documentation
WG3	Open Distributed Processing (ODP) – Enterprise Language
WG4	Tools and Environment
WG5	Open Distributed Processing (ODP) – Quality of Service
WG6	Evaluation and Metrics
WG7	Life Cycle Management
WG8	Support of Life Cycle Processes
WG9	Software Integrity
WG10	Process Assessment
WG11	Software Engineering Data Definition and Representation
WG12	Functional Size Measurements
WG13	Software Measurement Framework
WG14	Enhanced LOTOS.

Some of these working groups are highly relevant to the mission of INCOSE (see below).

How Standards are Developed

An ISO standard under-development passes through the following versions:

- Working draft (WD) — an initial draft circulated by the Secretary or Convener of a committee or working group for consideration by its members;
- Committee Draft (CD) — a proposal for the text of an International Standard, prepared in International Standard format, which is submitted to a technical committee or subcommittee for consideration. The final CD undergoes a ballot within the (sub)committee;
- Draft International Draft (DIS) — a CD that has received substantial support from participating members of a technical (sub) committee and is circulated as a DIS to member bodies for approval; and
- International Standard — a DIS that has received requisite approval.

The Curitiba Meeting – May 23-28, 1999

The purpose of the Curitiba meeting, held over 23-28 May 1999, was to advance the business of SC7 and its working groups. In general, major decisions are made and direction given to the developers and editors of applicable standards and guides.

System Life Cycle Standard ISO/IEC 15288

ISO/IEC 15288 is a standard being developed for the total life cycle of systems, including the system development phase of the system life cycle. Although not a systems engineering standard per se, ISO/IEC 15288 aims to foster system success by:

- defining life cycle processes that reflect good systems engineering principles; and
- requiring that, for a given system, a system life cycle be planned and implemented in accordance with the standard.

Mr. Stuart Arnold (UK) is editor of the standard. Stuart is a well-known and respected member of the UK Chapter of INCOSE. Also at the meeting, Mr. Bud Lawson of Sweden was appointed to the new position of 15288 Architect. Bud is also a distinguished member of INCOSE. It is planned that INCOSE thoroughly review the Committee Draft of ISO/IEC 15288, using review procedures considered by the Standards Technical Committee at Brighton. Participation in the review of qualified INCOSE members is a key element of the plan.

Process Repository

SC7 is developing a Process Repository as a means of fostering consistency and improved integration between SC7 standards. A first draft of the Process Repository was submitted to National Bodies for

comment prior to the Curitiba meeting. A Special Working Group will further develop this resource. It is expected that INCOSE will make formal input to development of the Process Repository.

SPICE – ISO/IEC 15504

SPICE – ISO/IEC 15504 is an existing Capability Maturity Model framework, which is to undergo revision to facilitate the future incorporation of systems engineering (and other) reference models and assessment methods.

Progress from the ISO 10303-AP233 Working Group

Sylvain Barbeau, AP 233 project leader, sylvain.barbeau@espace.aerospatiale.fr, and Julian Johnson, INCOSE TIWG member, julian.johnson@bae.co.uk

A productive meeting was held in Lillehammer in Norway June 6-11, 1999. The full team was present and has planned to release the 4th Working Draft document before the next meeting to be held in New Orleans, November 7-12, 1999. This 4th Working Draft will reflect comments received on the current release of the document with respect to editorial points, and on scope and model extensions. Several extensions have been scheduled for this 4th issue. The main ones deal with:

- Enhancement of the requirement aspects, where additional capabilities are being worked out. This new structure will allow better and more flexible classification so that the model can be widely used across many industries and will allow a larger range of requirement types with additional attributes (such as requirement priority, and non-functional properties) to better reflect the industrial approach in handling requirements.
- Additional features to model behavior. The current release

features three ways of describing behavior: finite state machine, causal chain, and synchronous behavior model. The fourth capability being added is a stimulus-response modeling paradigm, treating the behavioral system as a block box and describing the values of its inputs and outputs over time. This new feature will complement the existing approaches and achieves a rich behavioral modeling vocabulary.

In order to better indicate the applicability of the Application Protocol — a domain-specific transfer format — to the full system life-cycle, a model based on the system engineering process combined with the full life-cycle support model from the Product Life Cycle Support (PLCS) initiative is being added to the new release of the document.

During this meeting, several milestones have been reached, such as harmonization of points of view with the overall STEP structure and framework. This point is very important since it underlies the interconnections that exist between several Application Protocols, across different engineering domains. This is mandatory since the systems engineering discipline interacts with the whole range of engineering disciplines support by “domain engineering” Application Protocols.

The liaison between INCOSE and ISO TC184/SC4 has been officially presented to the whole STEP community during the “liaison plenary” meeting, a time slot dedicated to reports on the liaisons between STEP and the wider community. It is currently expected that the liaison representative from INCOSE will present a view of the INCOSE organization and its objectives during the next session in November. The STEP community, indicating a strong interest to know more about INCOSE has welcomed this proposal.

The final point worth mentioning comes from the recent NASA press

release indicating that STEP is now part of the normal standards used by NASA to support electronic data exchange between its design tools. Even if this press release is based on the CAD and manufacturing Application Protocols, it indicates the strong commitment from NASA to make use of the STEP standard.

More information can be downloaded from the following web sites:

- SEDRES web site:
<http://www.ida.liu.se/projects/sedres/index.html>
- NIST web site:
<http://www.nist.gov/sc4> (this site contains all the official and up-to-date files from ISO. Verbatim meeting minutes will also be made available on this web site shortly).
- NASA Central website <http://mis-spiggy.gsfc.nasa.gov/step>

Alternatively, contact either of the authors at the e-mail addresses above.



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THANK YOU FOR VISITING US IN BRIGHTON



The Fourth Australian Conference on Requirements Engineering (ACRE'99)

29-30 September 1999

Sponsored by

CSIRO-Macquarie University

Joint Research Centre for Advanced Systems Engineering (JRCASE)

Macquarie University, Sydney, Australia

<http://www.jrcase.mq.edu.au/conference/acre99.html>

To be held at Graduate School of Management, Macquarie University

CALL FOR PARTICIPATION

Over time, it has become clear to software developers and practitioners that one can achieve better quality in software development process and product if our methods and tools for gathering, modelling and analysing user requirements are more effective, robust and codified in practice. Therefore, Requirements Engineering (RE) in recent years has emerged as an important field of research and practice within software engineering and information systems. It also has widespread implications in other related fields such as systems engineering and human-computer interaction. Since the word "engineering" has been attached to "requirements," RE research efforts have endeavoured to incorporate an engineering approach to what was traditionally known as systems analysis.

The Fourth Australian Conference on Requirements Engineering is organised to bring together practitioners and researchers from academia and industry who work in the field of requirements engineering and to foster the development of a RE research community in Australia. The conference will consist of presentation of contributed papers and panel sessions with the aim of opening up some common strands and/or opportunities for collaboration. Participation by active researchers both in industry and academia and by research students is strongly encouraged.

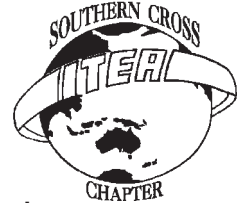
Paper submissions will be evaluated by the members of the program committee for their applicability and relevance to requirements engineering, originality, significance, soundness, and clarity. Accepted papers will be published in the Conference Proceedings.

SETE99 - CALL FOR PAPERS



Systems Engineering, Test & Evaluation Conference
Conceiving, Producing and Guaranteeing Quality Systems
Adelaide, South Australia, 20-22 October 1999

A Symposium of
The Systems Engineering Society of Australia and
The International Test and Evaluation Association
Earn an AUS\$100 rebate on SETE99 attendance by presenting a paper!



The SETE99 Symposium theme is "Conceiving, Producing and Guaranteeing Quality Systems." Papers are invited relating to this theme, as well as to the traditional tracks and special interest areas of SESA and ITEA. Registrations of interest are also sought from potential exhibitors. SETE99 will include both exhibitions and presentations by vendors.

Conference Program

The conference program integrates the systems engineering and test & evaluation fields in a combination of plenary sessions, panels, technical papers and exhibits. The program is expected to include papers in at least the following areas.

Systems Engineering:

Systems Engineering Applications
 Selling Systems Engineering
 Measurement
 Modelling and Tools
 Systems Engineering Management
 Processes and Methods
 Software Engineering
 Education and Training

Test & Evaluation:

T&E Visions of the Future
 Critical Technologies (Instrumentation, Modelling, Simulation)
 Measures of Effectiveness (MOEs)
 The Planning and Management of T&E
 T&E Investment Planning
 Virtual T&E
 The Design of Experiments

Error Budgeting
 T&E for Systems of Systems
 T&E - The Value Added
 T&E - The Legal Issues

Papers will be reviewed anonymously by at least two peer reviewers. For each paper submitted, prospective authors are requested to submit by email two files: a separate Identification Page and the paper, both in Microsoft Word, using Times New Roman 11 point font, and in single column format. An example paper, which may be used as a template, is at <http://www1.tpgi.com.au/users/agabb/sete99.htm>

The Identification Page is to include the following:

- Paper title
- Author name(s)
- Business affiliation(s)
- Address(es)
- Phone number and fax
- E-mail address(es)
- A short biography for each author.
- Primary contact to be used for all communications.

The preliminary paper is to have a title page with abstract (but no author information), 5-8 numbered pages in length, including figures, tables and other illustrations. Upon acceptance, paper format requirements will be sent to the primary contact.

Technical session paper presentations will be 20-30 minutes in length, plus a 10-15 minute question and answer period. Papers accepted for presentation at SETE99 will be published in the Symposium Proceedings in both book and CD-ROM form.

Important Dates:

Draft Paper Submission:	7 July 1999
Acceptance Notification:	25 August 1999
Ready Paper	15 September 1999

Late papers may be accepted - contact the Technical Chair for further information.

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SESA is a Technical Society of The Institution of Engineers Australia (IEAust), affiliated with the International Council of Systems Engineering (INCOSE). SESA's website is at <http://www.adacel.com.au/sesa/>

Commentary

It's the Interfaces!

Ginny Lentz, virginia.lentz@otis.com

Commercial Systems Engineering is typically regenerative product engineering. By that I mean that we are basically making the same product, performing the same basic functions, with similar operational behavior, again and again with some performance improvements. We can preach requirements analysis and functional analysis and not make a difference. Systems analysis and control and verification become the most frequently used systems engineering processes.

The key requirements to be managed are the Business Requirements. That is not to say there are not customer requirements—they exist and are relatively stable from generation to generation across product families. In the DOD type world, we recognized the need to deal with at least two levels of customers: using agency and acquiring agency. In the commercial world, the levels of customer range from the end user to a broad series of customers, each with their own set of requirements and priorities. The commercial customer, however, does not write a specification for the product — one must cajole the requirements out of the customer with surveys and focus groups and demonstrations...and then put a product in the market and wait for acceptance. Changes in customer requirements are frequently driven by what the competition provides, thus creating an expectation by the customers. In many cases, the requirement has been there all along — the technology is now ready to meet the need. Balancing the requirements becomes the key task of the commercial systems engineer.

The commercial functional requirements were developed when the company founders started the

business and designed the first item/product. These functional requirements are important when considering innovation and revolutionary product redesign; applying discontinuous innovation for performance improvements. However, many of the functional architectures described today use nouns, rather than the verbs. Thus many commercial industries presume the translation from the functional to the physical.

From product to product and from generation to generation, whether changes are called incremental development, modernization, or block updates, the key to achieving aggressive time to market goals is reuse of parts, whether the parts are called hardware, software, components, or subsystems. The innovation from part to part and subsystem to subsystem varies over time. Also, innovation in component A is generally out of phase with innovation in Component B. The competitive driver of better-faster-cheaper precludes agile, customer sensitive companies from accumulating innovations in one part until innovations are available for all, or even many, parts. Placing the new component A in the system will drive changes to Component B and C...how many others? It might also enable an additional capability (a.k.a. function) that may also place constraints and requirements on previously existing components. All this is manifested in the interfaces. After several of these generations, what does the system level interface diagram look like at the operational, functional, and physical level? It is definitely not simple. Optimization for a specific product is frequently driven by those business requirements, always with the thought that someday, we will optimize the interfaces.

It is the physical, build-to requirements that change — and they need

to be managed as much as analyzed. Particularly, when we plan to reuse already built components (the hope is without change) — but, we only have a few people who really know how it was built. Yes, we need the documentation (oops, I really meant information capture). And, we need the traceability to the implementation of a requirement as represented in the product data manager in the factory (far on the other side of the manufacturing Bill of Materials). It is in the product data manager that the failure data might be collected, or at least where a connection to the failure data can be found. We need it because one business requirement is to reduce the warranty costs, and that means increasing product reliability. The contributing reliability of the reused components, and thus the circle, continues with a new set of interfaces to be managed.

Do we see the same stuff in the INCOSE legacy business arena? Yes, but the acquisition and development times in commercial are 18 to 48 months, not years. The life cycle of the commercial product can also be 50 to 100 years, like the defense business. The system modernization/replacement cycle is much longer in the defense business, necessitating more of a top down, technology driven look...and by the time the DOD Aerospace community decides to start a new product development, the old components are so obsolete few would think of reusing them. Is there a need to focus on this interface driven systems engineering with the thought that it can provide insight to the design of systems of systems, of systems that I heard so much about at INCOSE '99? I think so.

History Revisited – A Commentary

Dr. Edouard Kujawski,
Ed.kujawski@lmco.com

In the past year the U.S. aerospace launch industry has suffered a series of six consecutive failures, which involved three Titan 4s, two Delta 3s, and the Athena 2. The Titan 4 is a military launch vehicle; the Delta 3 and Athena 2 are new commercial launch vehicles. The losses – launch vehicles and their payloads– exceeded \$3.5 billion. The technical or immediate causes of these failures have been identified as badly loaded software, an electrical short, and faulty guidance.

Almost forty years ago, the Ranger Program had a series of six consecutive failures — starting with Ranger 1 in 1961 and ending with Ranger 6 in January 1964 — before Ranger 7 successfully impacted the moon in July 1964. This was followed by successful Ranger 8 (February 1965) and Ranger 9 (March 1965) missions.

In April 1963, Richard Feynman gave a remarkable series of lectures at the University of Washington. These have recently been published under the title, *The Meaning of it All, Thoughts of a Citizen-Scientist* (Perseus Books 1998). Here are his comments on the Ranger Program (page 112):

“Another thing is the Ranger Program. I get sick when I read in the paper about, one after the other, five of them that don’t work. And each time we learn something, and then we don’t continue the program. We’re learning that somebody forgot to close a valve, that somebody let sand into another part of the instrument. Sometimes we learn something, but most of the time we learn only that there is something the matter with our industry, our engineers and our scientists, that the failure of our program, to fail so many times, has no reasonable and simple explanation. It’s not necessarily that we have so many failures, as far as I can tell. There’s something

the matter in the organization, in the administration, in the engineering, or in the making of these instruments. It’s important to know that. It’s not worthwhile knowing that we’re always learning something.”

Richard Feynman was one of the leading physicists of his time, a Nobel Prize recipient, and may be most widely known to the public for his involvement with the Space Shuttle Challenger investigation. In his unique style, Feynman gives account of this investigation in “*What Do You Care What Other People Think?*” (Norton & Company 1988).

Reform of the Systems Engineering Working Groups

George Caple, george.caple@gecm.com

For some time, I have been interested in the structure, or perhaps I should say “non–structure” of SE Working Groups on both sides of the Atlantic. I raised this at a recent Requirements Engineering WG meeting at INCOSE 1999 in Brighton, and we had an interesting debate.

Certainly, I can see no integrated relationships, and would ask whether anyone else has views on the need to introduce improvements, to enable WGs to be more able to understand their aims, boundaries, interfaces, and relationships with each other. I believe that energy directed this way would be immensely beneficial to the advancement of the comprehension of SE and its real world application.

It is obvious to those who have met me, that my way of introducing such improvements would be based on my Generic Unified Systems Engineering Metamodel (two published papers and more on the way). Use of this model for the structuring of working groups in a manner based on the designing of systems, in my opinion, would pave the way ahead.

Anyone like to hear more? Please contact me.

The Center of the Universe and Systems Engineering

Ingmar Ogren, iog@toolsforsystems.com

It is now almost five hundred years since the Italian astronomer Galileo Galilei verified Copernicus’ theory about the earth’s movement in relation to the sun. The Catholic Church at that time found the theory unsettling, and managed to get Galileo sentenced to lifetime imprisonment. The Church also made Galileo admit officially that the earth is fixed. It is said that after his admission Galileo mumbled, “and still she moves.”

In the May issue of *Scientific American*, it is reported that astronomers have now established a center of our galaxy and calculated how our solar system moves around this center. Another five hundred years and maybe the astronomers will have found the center of the universe and calculated how our galaxy moves in relation to that ultimate center.

However, for everyday purposes, most of us adhere to Church’s view of five hundred ago when we say that the sun rises or sets, although we are well aware of the “fact” that the earth moves around the sun. This may seem to be a contradiction, but is not, since what has happened since Galileo’s time is that we have understood that all movement is relational and that the question of what moves and what is fixed simply depends on how you arbitrarily select the “fixed reference point.” The conclusion is that the discussion between Galileo and the Church was quite unnecessary. They simply used different reference points!

Einstein is said to once have asked on board a train: “Does Chicago stop at this train?” This question illustrates that the “fixed reference point” need not be a planet or a sun, but can well be a train. Furthermore most of us experience the world from our own mind and body, meaning that we are all walking “Centers of Universe!”

What has this reasoning about relativistic theory to do with systems engineering? In fact a lot, since any work with complex systems will involve a great number of people (stakeholders), all of which will have their own view of the universe and of the system con-

cerned. Each of the stakeholders will have an understanding of how the system can be useful, and of his or her own role in the system. The differing expectations also mean that stakeholders will have different and well-motivated understandings of the required system quality.

If you accept this relativistic view on a system and its stakeholders, it results in some requirements on systems engineering methods and tools:

- A single hierarchical system structure is not enough. Most system engineering methods presuppose that the system is described as a single hierarchical structure. However, the different stakeholders will have their interest focused on different parts and on different levels of the system. This means that the system should be structured and described in a way, which allows for different focal points for different stakeholders, with a possibility to expand independent views of the system from each of these focal points.
- Missions must be highlighted. Systems engineering tools often concentrate on technical details, while stakeholders primarily need to understand what missions are supported by a system, and how these missions fit into and support the stakeholders' personal "View of the Universe." Consequently, it is not sufficient to describe technical details, but a systems engineering tool must also support clarification of the system's missions with connection between these missions and the system's technical and human components.
- System components must be allowed to depend crosswise on each other. Even if we are all "Centers of Universe," we still depend socially on each other in complicated and often crosswise dependencies. The same is true for system structures and system descriptions. Two components, which may be human or technical, will often depend on each other to complete a common mission. A simple example is a car driver and the driver's car:
 - The driver depends on the car to complete the primary mission of travel.

- The car depends on the driver to complete the secondary mission, "service car."

The methods and tools applied in systems engineering must be able to model and clarify such crosswise dependencies between system components.

- Different views must be supported and unified. As explained above, different stakeholders have different views and also different needs of information. Traditionally, this has led to requirements for large amounts of documentation in systems engineering. Introduction of a multitude of different documents introduces a risk that the different documents do not comply with each other and also requires a superhuman capacity to review the different documents to ensure consistency.
- The conclusion is that system information must be kept in a common information base, which is computer-supported to be kept consistent. Also that the different documents, needed by different stakeholders, should be generated as "projections" from the common information base.
- The focal point must be simple to move with retained consistency. Since a complex system, by its very nature, is not humanly understandable in its totality, it is necessary that system engineering tools be designed to focus on a part or an aspect of the system at a time. This understanding leads to requirements on systems engineering tools:
 - It must be simple to change focus to different parts of a system.
 - It must be simple to change focus between aspects of a system (for example missions, requirements, behavior, interfaces, documents, etc.
 - The tool shall include automated support to ensure that the different parts of the system retain consistency between each other.

The above reasoning aims at showing that relativistic aspects should be taken into account, when designing system engineering methods and tools to satisfy

the different stakeholders, concerned by a complex system. The reasoning may also be extended to the conclusion that a system in itself is a valid "Center of Universe" for modeling and description purposes.

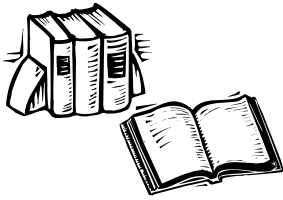
Response to the "Case for SE Capability Maturity as Selection Criteria"

Howard Korman, dak10@earthlink.net

I am responding to Joe Romano's article in the Spring 1999 of INCOSE **INSIGHT** regarding an expanded use of a systems engineering (SE) capability maturity model (CMM).

In the competition for resources within a company, any process must be deemed cost-effective to be worthy of resource investment. It must stand on its own merit to make sense in a competitive environment for dollars. Any artificial, externally imposed process that does not add value will not stand the test of time. I agree that there is a need for a logical approach to treating SE in contractor selection. The SE CM (i.e., EIA/IS 731) was developed for enterprise (company/division/profit center) level evaluations that would lead to SE process improvement. It uses qualitative elements to establish a maturity level. As long as there are no metrics that evaluate how effective the process is, its application beyond internal evaluations is suspect.

For contractor selection the enterprise-level SE process needs to be tailored to specific program needs and for each individual bid. I suggest that the contractor selection officials evaluate the tailored SE process being proposed, determine how successful it has been in past implementations by the bidder, and assess how it will be implemented for the program. Save usage of the SE CM for its original intent—internal enterprise level evaluations.



Book Reviews

Why Flip a Coin? The Art and Science of Good Decisions

by H. W. Lewis, John Wiley and Sons, 1997.

Reviewed by Jack Ring, jring@amug.org
[Note: Reviewer's personal comments in brackets]

You don't need a thick, esoteric book to help you do systems engineering better. *Why Flip a Coin?* is an excellent example. In only 200 pages, author Lewis, Professor of Physics, Emeritus, University of California at Santa Barbara, describes the many uses of good decision making as well as the numerous pitfalls to avoid. It is written in a common sense style laced with humor that helps make the material memorable. The book is organized in three parts, fundamentals, applications, and implications. The implication chapters are mostly concerned with the vagaries of humankind's social and political bodies.

The author probably didn't intend to clean up the thinking of the SE community but he certainly lays out the opportunity for those who care to learn SE beyond the single mission, ballistic methodologies prevalent in our craft. This little book states strong reasons for: 1) problem space modeling (to get the facts), 2) sponsor value clarification (clarifying the objective with acceptance criteria before seeking requirements), 3) risk assessment and risk-factored work planning, and 4) incremental design with an iterative method (with a convergence technique and stopping rule), as well as 5) the folly of ordinal-type capability assessment models.

Chapter 1 clarifies the basics — a decision problem consists of: 1) a possible set of actions, 2) a possible set of outcomes of these actions, 3)

some estimates of how likely each outcome is (given the decision) and 4) some kind of preference rating for the possible outcomes. These basics apply in several facets of systems engineering such as; 1) in system design and architecture, 2) planning SE activities and priorities, 3) qualifying the capability of a given SE team, 4) ensuring the value of a delivered system and even 5) clarifying the value of SE in any project or problem solving situation.

The Dating Game chapter discusses how to make choices in a date-rate-wait situation. [Although described in terms of spouse hunting the same game occurs in hiring new people or staffing a new project.] This type of decision making differs from the classic trade-off study wherein all the options are known at the beginning and can be evaluated simultaneously. Rather, there are many situations where choices come sequentially and a choice not made cannot be revisited. It turns out that the best method to use depends on your objectives. One objective is to "pick the best" but another is to "avoid the worst," and yet another is to avoid taking so much time to make a decision that the best candidate comes and goes [as in authorizing design releases before the reliability analysis results are known].

Calculating the likelihood of an outcome is, of course, rooted in probability math. Nothing new here, but the author does restate the three basic laws of probability.

However, the chapter on Gains and Losses explains that rating the consequences of a decision is another matter. The math for this does exist but the "people factor" creeps in and overwhelms rational decision-making. If decision-makers do not care how a decision turns out, then the decision process is

moot. Accordingly, the author stresses that if people are not affected by the outcome then they should not be involved in the decision process. Utility is "Gain with a Preference" and is typically asymmetrical, non-linear, and intransitive. Here we can get into trouble by playing on the field of ordinal systems (putting things in order) and trying to create cardinality (positions on a scale) so that further manipulation is possible.

The author moves from making decisions in the context of uncertainty (pure chance) to multi-party decisions in zero-sum games. Here he highlights the errors typically made in modeling such games. Also, he explains how stable "islands" may arise in such situations but that such stable solution sets may not be reachable from all starting points.

The Prisoner's Dilemma is next and is related to the all-too-familiar tradeoff situation call the Tragedy of the Commons by using the case of a group of herdsmen whose flocks graze a common pasture. Each individual herdsman does better when he increases the size of this own flock, but if all herdsmen do so, the pasture will be overgrazed and all will suffer calamity. And, if they do agree to mutually limit the size of their herds, the one who cheats will prosper. Thus, this is not a stability-seeking solution. [OPEC? Population growth?]

Let's move on to competitive games and the mini-max criteria. In such situations, a player has two options (objectives): seeking to win the most or seeking to lose the least. Seeking to do a balance of both is called "straddling" — putting part of your resources toward maximum gain and the balance toward minimum loss. With enough information about possible choices and outcomes, we can even calculate the "best" ratio of resources on each side and make an inherently unstable game a stable one [useful in risk mitigation?].

Rankings are used when we cannot put a specific value on an outcome. Rankings say that "Level 2

is better than Level 1,” but do not say how much better. The built-in ambiguities of ranking systems provide ample opportunities for astute participants to manipulate the results. This is why voting is one of the surest ways of arriving at an undesirable result.

The author stresses, again, the importance of knowing your objectives before making decisions. For example, in selecting a leader do you want one who represents the exact profile of the wants and needs of the populace? If so, you are headed towards the Tragedy of the Commons because the more people involved in a decision the more likely the outcome will be essentially “do nothing” [this is how de facto standards become popular]. In our modern, “wired,” societies, there are simply too many ways to stop things and too few ways to keep them going.

The Impossibility Theorem, which proof earned author Kenneth Arrow a Nobel Prize, says that there is no way at all to invent an unambiguous decision making rule for multiparty, multi-criterion decisions based on rankings. The danger of using preference rankings (ordinality) is clear. The advantage, in fact the necessity, of utility-based decisions (cardinality) is common sense. But even with utility-based decision methods it becomes increasingly difficult to establish preferences when the choices become more diverse. Accordingly, rather than ranking preferences, one should use a utility measure on the preferences [measures of effectiveness].

Even so, the utility of some outcome is strongly biased when people are influenced by the time factor. An outcome several months from now simply is not as attractive as the exact same outcome today. For many at least, it is also the case that a distant loss is not as fearful as a present one. As an example, the author cites the silliness of current EPA rules that require radioactive waste disposal by methods that will last 10,000 years. Accordingly, while people work on the solution, the

rest of us are lulled into a false security.

Public decisions are influenced by authority, the common good, taxation without representation, representation without taxation [the legacy of the one-man-one-vote fans or the save-the-spotted-owl campaigners] and uncertainty. Unfortunately, most public decision-makers are not versed in the basics of good decision making. For example, practically none can tolerate the ramifications of uncertainty.

Lanchester's Law is a must read for all systems engineering practitioners who are engaged in any aspect of competition. Alongside Moore's Law and Metcalf's Law, Lanchester's Law can be very valuable when deciding architectures or prioritizing SE activities when triage is necessary. In Lanchester terms, Strength is measured by the square of the number of Units (weapons imbalances are reflected with force multipliers). When Units engage in competition, Outcomes depend on a constant — the difference between the squares. For example, if a force of five units confronts a force of three units, their relative strengths are 25 vs. 9 and the constant is 16. The expected Outcome is that when the smaller force is wiped out, the larger force will still have the strength of $0+16 = 16$ or 4 Units. The relevance of this law to decision making is that a smaller force can still win if they make the right series of decisions. If, for instance, the smaller force can maneuver the larger force into a battle in which the larger force is split into two parts, one of which is smaller than your small force, then you have the Strength advantage and can win the first battle. Repeat enough times and you win [the case for iterative design with separation of concerns].

Lanchester's Law is more dramatic in three-party cases. Here it becomes clear how two weaker parties can gang up to defeat a strong party, then fight it out themselves to determine the eventual winner. This, of course, yields the least-worst solution to the original need. [Thanks a lot, Ross

Perot. And, how many times have we seen this behavior in interface control working group meetings?]

The book ends with a 13-point summary that every SE practitioner should be sure to understand.

Rescuing Prometheus

Thomas Hughes, Pantheon, 1998

Reviewed by Lori Pajerek,
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After a half century or so of recognized existence, the science and art of Systems Engineering (SE) has accumulated enough of a past to be viewed through the lens of historical perspective. At the recent symposium in Brighton our awareness was focused on the global spread of SE, and its increasing application to purely commercial endeavors. One of the recurring themes of the keynote speeches at the Ninth Symposium was the role of SE as a force for good (perhaps not surprising at a convention of systems engineers!), and the hopeful anticipation for greater societal benefits in the future as SE extends its reach.

In *Rescuing Prometheus* (Pantheon, 1998), Thomas Hughes reminds us that the foundations of SE are very much rooted in the United States' military-industrial complex so despised by the young American liberals of the 1960s and 1970s as an icon of cultural evil. An interesting irony implicitly highlighted by this book is that the term “military-industrial complex” fails to acknowledge the major role played by the academe, from which emanated some of the most visual and vocal protests to that establishment. Employing a bit of lexical revisionism, Hughes on occasion uses the phrase “military-industrial-university complex.”

Hughes' book chronicles four system development projects undertaken in the U.S. between the 1950s and the 1970s: the Semi-Automatic Ground Environment (SAGE), the

Atlas Intercontinental Ballistic Missile (ICBM), Boston's Central Artery/Tunnel (still underway), and ARPANET, the forerunner of today's Internet. But *Rescuing Prometheus* is much more than just a deconstruction of those four systems; it is a highly readable account that combines description of technical evolution, biographical cameos of the pioneers of SE, and exposition of the principles of what is variously termed systems engineering, systems analysis, systems management, systems approach, or just plain systems thinking.

The human angle is perhaps the most compelling thread in this well-woven tale. It is instructive for today's SE practitioners to learn how effective compromises were (often painfully) forged by clashing personalities from diverse backgrounds. For this reader, some of the most interesting insights offered by Hughes are those that demonstrate the permanence and persistence of such age-old

phenomena as the "Not Invented Here" syndrome. As accustomed as we are to the association of SE and the DoD, it is fascinating to read about the strong resistance from the military when the government imported scientists and managers from industry and academia. Senior officers resented and resisted the recommendations of the "Whiz Kids" appointed by then Secretary of Defense Robert McNamara. Many years passed before a tour of duty in the Pentagon's Systems Analysis Office (headed by RAND economist Alain Enthoven) was no longer viewed as a blot on a military career.

Hughes also describes how the early success of SE in military projects led government officials to apply the same analytical and managerial principles to social problems, with mixed results. Its account of Jay Forrester's development of computer models of urban systems also foreshadows a more whimsical application of SE: Forrester's 1960s model

draws an irresistible comparison to the 1990s Sim City® computer games!

This book is recommended to anyone interested in the people and forces that shaped a technological revolution that in turn has had deep and wide-ranging influences on the society we all inhabit. You don't have to be an engineer to understand and appreciate the story that Hughes tells in a lucid fashion accessible to all readers, but systems engineers especially will enjoy this exploration of their discipline's formation.

Dysfunctional Flow/Stan Long

Longse@tst.tracor.com



Do you have ideas for Stan's next cartoon? Contact him at longse@aol.com

INCOSE '99 – After the Event

Peter Robson, Symposium General Chair, peter.robson@baedsl.co.uk, peter@robsonpg.demon.co.uk; John D Mead, Symposium Marketing & Patron Programme, jdmead.a0030182@infotrade.co.uk



What an International Success! Delegates from 21 countries, four more than last year. One hundred and seventy new members. The reach and reputation of INCOSE around the world has been given a real boost through the quality and success of this event.

Whilst outside of the Metropole hotel, “sunny” Brighton lived up to its reputation for only part of the time, within the Metropole things were very sunny indeed. The quality of the program was self-evident with over one hundred and sixty top papers and views from around the world in thirteen panel sessions. Three plenaries, eighteen tutorials and the Academic Forum at the University of Sussex, all contributed to a packed and exciting program.

The exhibition opened on the first evening for a reception for over 500 delegates, providing a good start to the main part of the Symposium.



Still laughing at Laurie Taylor's jokes or was it the photographer?



Peter Robson with keynote speakers Professors Joan Solomon and Philip M'Pherson

This, and the proximity of all events around the exhibition hall with refreshments served there, kept the exhibitors happy. Thirty-five organizations were represented in the exhibition, which had fifty booths.

The invited speakers gave us plenty to think about. Sir Robert May expounded his theories and practical experience of high technologies and blew holes through a few preconceived ideas relating national success stories to national populations and rewriting the league tables in the process. Our Banquet speaker,



Banquet speaker, Laurie Taylor entertains the audience

Laurie Taylor, amused us with his views on the effect of everyday technology upon the family and society whilst raising some fundamental concerns about the importance of human interactions. Professor Joan Solomon appealed to the process and support needed to teach and establish systems thinking within the educational environment, and

Professor Philip M'Pherson told us systems engineering was nothing new and provided a forty-five-year history with documentary evidence.

The ongoing work of INCOSE was evident through the activities of the Technical Board, Committees and Working Groups. One objective of the Symposium was to encourage new membership of the Working and Interest Groups. The Chapters and Membership Committees were busy with advising the growing number of start up and emerging chapters.

This article is being rushed to meet the **INSIGHT** deadline, and before detailed statistics are to hand and all reports are returned and analyzed. Unsolicited responses such as “I am proud to be an officer of INCOSE. All of you did a terrific



Attendees raving about the fabulous food

job”, “I can't remember a symposium that was clearly better run, and I have been going since 1992. In addition, you were working with new challenges. Three cheers for a job well done!” “I just returned from Brighton and want to tell you I thought it was one of the finest symposia I've ever attended — of



Fariba Hozhabrafken, Region III Director, and Donna Rhodes, President Elect, are caught taking a break

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any organization." "My respect for INCOSE grew enormously as a result of the symposium." These comments really do make the whole of the INCOSE '99 team immensely proud and grateful for the opportunity to help in the strategic growth of INCOSE. Exhibitor questionnaire responses were very enthusiastic, even if some were hungry!

The support of our nine Patrons was fantastic and absolutely necessary for INCOSE to be able to commit to such a comprehensive celebration of systems engineering. We trust they were all happy with the result.

The biggest and the best? What do you think, only your personal experience will tell you if it was the best? The statistics tell us that there were 713 delegates and over 200 more exhibitor staff. Earlier predictions that Americans did not generally know where England is located were proven unfounded — 283 U.S. delegates found it, beating the home



Ginny Lentz received a Founders Award

audience by 17! We hope that they all found it worth the trip and enjoyed it as much as we all did.

If you were unable to attend and now want a copy of the *Proceedings*, may we suggest that you contact the INCOSE Central Office <incose@halcyon.com> as soon as possible? Supplies of the hard-copy *Proceedings* are limited; there were two volumes of papers this year, some fifteen hundred pages in total, a veritable cornucopia of systems engineering information! Also, keep a watch



Who put these wine bottles on our table?

on the INCOSE '99 and main INCOSE web sites; we intend to post such material as authors, panelists and tutorial providers are willing to release for either public or 'members only' consumption; this will, however, take a little while to organize.

The General Chair's biggest challenge? Perhaps it was orchestrating the closing plenary; this has a reputation of over-running! There was a grim determination to get all the contributors to provide brief summaries of INCOSE's work during the week, supported by slides assembled into a single presentation. Confronted by this demand, all the INCOSE officers and others involved responded magnificently and with good humor; a 74-slide presentation was assembled in about two hours from nearly 20 contributions. We only got one slide in the wrong place and although the plenary started ten minutes late, it finished only three minutes late!



Peter Robson, INCOSE '99 General Chair, momentarily escaping his duties

Photos provided by Valerie Gundrum

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Best Paper and Best Presentation Awards

Allen Fairbairn, Symposium Technical Chair,
agf@applesys.demon.co.uk

There were two types of awards this year — best papers as submitted and best presentations at the Symposium.

Best Papers

There are seven awards corresponding to the seven Technical Committees that were responsible for reviewing the submitted papers. All of the 295 papers submitted were allocated to one of the technical committee subject areas. Reviewers assigned to that area by virtue of their experience and particular systems engineering interest marked the draft papers. A minimum of four reviews per paper was almost universally achieved. The five highest scoring papers in each area were again reviewed at the final paper submission stage in order to confirm or alter the original ranking and to take tie-breaking decisions, where necessary. The results of the Best Paper assessments were as follows:

Education & Research: *System Theoretic Portents of Predisposition to System Failure*, Wayne Wymore, The University of Arizona

Measurements: *Estimating Risk Adjusted Cost or Schedule using Fuzzy Logic*, Laurence Bellagamba, TRW Space and Laser Programmes Division

Modelling and Tools: *Models, Proofs and the Engineering of Computer Based Systems: A Reality Check*, Gerard Le Lann, Inria

Processes and Methods: *Systems Engineering for Faster, Cheaper, Better*, Kevin Fosberg & Harold Mooz, Centre for Systems Management

SE Applications: *Application of SE Principles in the Development of the Advanced Photo System*, Gregory A Mason, et al, Eastman Kodak Company

SE Management: *Risk-Based Decision Support*, Barney Roberts & Louis Fussell, Futron Corporation

Standards: *Design and Implementation of a System Engineering Standard Process for Satellite Development*, by Markus Rudolph et al, IABG mBH, Germany

Best Presentations.

The Best Presentation Awards were based on Paper Evaluation sheets completed by delegates. There was no clear winner on scores alone. However, the following papers were all notable for their exceptional individual scoring and were given Best Presentation Awards accordingly:

Modeling of Integrated Product Development Processes, presented by Herbert Negele and Ernst Fricke Institute of Astronautics, Technical University of Munich, and Nicole Härtlein, BMW AG, Session 7.6 — Integrated Product Development. This paper was particularly distinguished by its effective presentation by the two presenters.

Application of SE Principles in the Development of the Advanced Photo System by Gregory A. Mason, et al, Eastman Kodak Company, Session 4.4 Case Studies: Commercial Applications. This paper had also been selected for a Best Paper Award under the SE Applications area

Tailoring Quality Function Deployment for Use in Systems Engineering by Catherine Plowman, Lockheed Martin Idaho Technologies, Session 6.3 — Adapting Systems Engineering Processes.

We also made an Award for the Papers making up the Best Session in the Symposium. Receiving more than two to three times the number of score cards than any other session, with very favourable comments on the contribution of each paper in the session, this Award went to the four papers making up Session 2.2, Soft Systems Methods:

1. *Controlling Rapid Change through Systems Engineering the*

- Organization* by Jairus M. Hihn, California Institute of Technology
2. *Systems Methodology for Real-Time Information Systems* by David H. Cropley and Steven C. Cook, Australian Centre for Test & Evaluation
 3. *Architecture for a Process Meta-System* by Valerie Gundrum, Lockheed Martin Federal Systems
 4. *Concept Mapping as a Communications Tool in Systems Engineering* by Mary Morgan McCartor, Boeing Commercial Airplane Company

Brian Mar Best Student Paper Award

It was not possible to make the Brian Mar Award for the Best Student Paper this year, due to uncertainty over the number of qualifying papers. Qualifying criteria will be carefully scrutinized next year and an award will be made.

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